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THE CONDITION OF WOMEN FROM A ZOÖLOGICAL POINT OF VIEW.

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I.

ZOÖLOGY is the scientific study of the past history of animal life, for the purpose of understanding its future history. Since man has, in part at least, conscious control of his own destiny, it is of vital importance to human welfare in the future that we should learn, by this comparative study of the past, what are the lines along which progress is to be expected, and what the conditions favorable to this progress, in order that we may use our exceptional powers in harmony with the order of nature.

The study of the growth of civilization shows that human advancement has been accompanied by a slow but constant improvement in the condition of women, as compared with men, and that it may be very accurately measured by this standard. Judging from the past, we may be sure that one of the paths for the future progress of the race lies in this improvement, and the position of women must therefore be regarded as a most important social problem. If there is, as I shall try to show, a fundamental and constantly increasing difference between the sexes; if their needs are different, and if their parts in the intellectual, moral, and social evolution of the race, are, like their parts in the reproductive process, complemental, the clear recognition of this difference must form both the foundation and superstructure of all plans for the improvement of women.

If there is this fundamental difference in the sociological influence of the sexes, its origin must be sought in the physiological differences between them, although the subject is now very far removed from the province of ordinary physiology. While we fully recognize the insig-

nificance of the merely animal differences between the sexes, as compared with their intellectual and moral influence, it is none the less true that the origin of the latter is to be found in the former; in the same manner—to use a humble illustration—that the origin of the self-denying, disinterested devotion of a dog to his master is to be found in that self-negation which is necessary in order that a herd of wolves may act in concert under a leader, for the general good.

In order to trace the origin and significance of the differences which attain to such complexity and importance in the human race, we must carry our retrospect back far beyond the beginning of civilization, and trace the growth and meaning of sex in the lower forms of life. In so doing I shall ask attention to several propositions which may not at first appear to have any bearing upon our subject, or any very close relation to each other. I shall then try to show what this relation is, and point out its bearing upon the education of women.

Every organism which is born from an egg or seed is a resultant of the two systems of laws or conditions, which may be spoken of abstractly as the law of heredity, and the law of variation, or, to use the old teleological terms, each organism is a mean between the principle of adherence to type and the principle of adaptation to conditions.

That like produces like is universally but never absolutely true. The offspring resembles its parents in all fundamental characteristics. The human child, for instance, resembles its parents in the possession of all the characteristics which distinguish living things from not living, as well as those which distinguish animals from plants. The chemical, physical, and physiological changes which take place in its body and the histological structure of its tissues are like those of its parents, and its various organs are the same in form and function. All the characteristics which unite it with the other vertebrates, as a member of the sub-kingdom Vertebrata, are like those of its parents, and also those which place it in the class Mammalia, and in its proper order, family, genus, and species. It also shares with its parents the features or race characteristics of the particular tribe or race to which they belong. If they are Chinese, Indians, or negroes, the child belongs to the same race, and manifests all the slight, superficial peculiarities of form, constitution, and character by which that race is characterized. Even the individual peculiarities of the parents, intellectual and moral as well as physical, are now known to be hereditary. Since this holds true of any other animal or plant, we must recognize the universality of the law of heredity, but we must not overlook the equally well-established fact that each organism is the resultant of this law and another, the law of variation. The child is like its parents, but not exactly like them. It is not even a compound of characteristics found in one or the other of them, but has individual peculiarities of its own; slight variations which may not have existed in either parent, or in any more remote ancestor. The slight

individual differences are so overshadowed by the much more conspicuous resemblances due to heredity — with which they compare about as the green buds at the tips of the twigs of a large tree compare with the hard wood of the trunk and branches, the growth of previous years—and they are so fluctuating and inconstant, that their importance may easily escape attention. Careful observation shows, however, that every characteristic may vary: those distinctive of the class or order as well as those which mark the species or variety. The variations may manifest themselves in the adult, or at any other period in the life of the individual. Even the eggs have individualities of their own, and among many groups of animals the eggs of the same parent, when placed under precisely similar conditions, may differ in the rate and manner of development. Although most of these individual differences are transient, and disappear within a few generations, there can now be no doubt that those which tend to bring the organism into more perfect harmony with its environment, and are therefore advantageous, may be established as hereditary features, through the action of the law of the survival of the fittest; and it is hardly possible to over-estimate the value of the evidence which paleontology and embryology now furnish to prove that all hereditary characteristics, even the most fundamental, were originally individual variations.

The series of hereditary structures and fnnctions which makes up the life of an organism is constantly being extended by the addition of new features, which at first were individual variations, and are gradually built into the hereditary life history. In this way newly acquired peculiarities are gradually pushed further and further from what may be called the growing end of the series, by the addition of newer variations above them. It can also be shown that from time to time the peculiarities at the other end of the series, the oldest hereditary features, are crowded out of the life of the organism, and dropped, so that an animal which is high in the scale of evolution does not repeat, in its own development, all of the early steps through which its most remote ancestors have passed. The series of hereditary characteristics, thus growing at one end and fading away at the other, gradually raises the organism to new and higher stages of specialization, and its evolution by variation and heredity may be compared with the growth of a glacier.

The slight individual differences are represented by the new layers of snow added by the storms to the deposit which fills the valley in which the glacier arises. The snows which are soon blown away are those variations which, being of no use, soon disappear; while the snow which remains in the valley, and is gradually converted into ice, represents those individual differences which are seized upon by natural selection, and gradually rendered hereditary and constant. The long stream of ice stretching down to lower regions, and made up of the

snows of thousands of winters, receiving new additions at its upper end, and at the same time melting away at its lower, is no bad representation of the long series of hereditary features, once variations, which form so large a part of every organism. If the glacier were not in motion, but stationary, so that the melting of the oldest portion and the additions to its upper end should gradually carry the body of ice up to higher and higher levels, we should have a very perfect parallel to the evolution of an organism by variation and heredity.

The steps in this progress are embodied in a long series of individuals, each of which is, either immediately or indirectly, the product of a fertilized egg or seed, through which the laws of heredity and variation act, to bind the separate individuals into a progressive whole. The seeds and eggs with which we are most familiar are highly complicated, and consist of the protoplasmic germ, which is intimately united to a mass of food destined to be converted into protoplasm during development.

The germ with its food forms the yolk of such an egg as that of the bird, and is surrounded by layers of albumen, which are also used as food, and by a complicated series of investing membranes. It originates in a special organ, the ovary, and is incapable of perfect development until it has been fertilized by the male reproductive element. In its earliest stage of growth it is simply one of the cells or histological elements of the ovary, but as it grows it soon becomes very much larger than an ordinary cell, and its protoplasm becomes filled with food material, and the outer layers and walls are added to it. In many animals, the external envelopes are wanting, and the egg is simply a very large ovarian cell, filled with food material, and capable of developing, under the influence of the male element, into a new organism. In still other animals the food-yolk is wanting, and the egg is small, and does not differ from an ovarian cell; and in still other animals the ovaries are lacking, and cells may become specialized as ova in various parts of the body.

The series is so complete that we may be certain that we are comparing strictly homologous structures, and we may therefore conclude that the egg is nothing but one of the cells of the body, which may, when acted upon by the male element, develop into a new organism, substantially like its parents, with some of the individual peculiarities of each of them, and also with new peculiarities of its own.

From the necessity for impregnation in most cases, it has been assumed that the essential function of the male element is to quicken the germ, and thus start the process of development. It is true that it does have this function in many cases; but comparative study shows that the egg itself is alive, and does not need quickening, and that this must be regarded as a secondary and derived function of the male element, not the essential and primitive function.

That this is the case is shown by the fact that, while the earlier

stages in the developmental process are sufficiently alike in different animals to admit of a comparison between them, the stage at which impregnation takes place is not fixed, but variable. In some cases the ovarian egg remains without change until it is impregnated; and the first step in the developmental process, the disappearance of the germinative vesicle, is the immediate result of the union of the spermatozoa with the ovum. In other cases the germinative vesicle disappears, and the egg then remains inactive until it is impregnated; and this is followed at once by segmentation. In still other cases segmentation takes place without impregnation. Other eggs develop still further; and, finally, there are many animals whose unfertilized eggs not only commence, but complete the developmental process, and give rise to adults which may in turn produce young in the same way: and this may go on indefinitely, without the intervention of a male. The queen bee is able to lay fertilized or unfertilized eggs at will, and they are equally alive and capable of development.

These facts show conclusively that the essential function of the male element is not the vitalization of the germ.

Turning now to another aspect of our subject, we find that among plants, and among all the lower and simpler groups of animals, new individuals are produced by the various forms of asexual generation, as well as sexually. In certain animals, such as the tunicates, this form of generation is highly specialized, and the stolon from which new individuals are budded off is a highly complex structure, which contains cells or tissues derived from all the essential organs and systems of the parent, and from these the corresponding organs and systems of the new individual are derived. As a rule, however, the process of budding is very simple: a mass of unspecialized cells at some definite point upon the body of the parent, animal or plant, becoming converted into a new individual, instead of contributing to the further growth of the old. Among the lower animals, such as the hydroids and sponges, the process is still more simple, and cells may become converted into a bud at almost any point upon the body of the parent. That the process of reproduction by budding is not in any way absolutely distinguished from the process of ordinary growth by cell-multiplication, is shown by the fact that an accident may determine which of these processes is to result from the activity of a given cell.

Comparison shows that there is, on the one hand, no essential distinction between ordinary growth and reproduction by budding, and, on the other hand, none except the necessity for impregnation to distinguish asexual from sexual reproduction. All these processes are fundamentally processes of cell-multiplication. As none of the animals with which we are thoroughly familiar reproduce asexually, we are unable to make any very exact comparison of the results of the two processes of reproduction in animals; but among plants such com-

parison can be made without difficulty, and will be found to show that variation is much more marked and common in plants raised from fertilized seed than in those raised by budding. A marked bud-variation is of very rare occurrence, but in many cases the tendency of plants raised from seeds to differ from the parents is so great that choice varieties are propagated entirely by buds. It is almost hopeless to attempt to propagate a choice variety of grape or strawberry by seeds, as the individuals raised in this way seldom have the valuable qualities of their parents, and, although they may have new qualities of equal or greater value, the chances are of course greatly against this, since the possibility of undesirable variation is much greater than the chance of a desirable sport. There is no difficulty, however, in perpetuating valuable varieties of these plants by asexual reproduction.

Putting together these various propositions—that the evolution of life has been brought about through the combined action of the law of heredity and the law of variation ; that in all except the simplest organisms the process of sexual reproduction by ova which have been acted upon by the male element is met with ; that the ovum is alive, and capable of development in itself, and that the essential function of the male element is something else than the vitalization of the ovum ; that the process of sexual reproduction differs from the process of asexual reproduction only in the occurrence of impregnation, while the result of the former process differs from the result of the latter in its greater variability—we seem warranted in concluding that the ovum is the material medium through which the law of heredity manifests itself, while the male element is the vehicle by which new variations are added. The ovum is the conservative, and the male element the progressive or variable factor in the process of evolution of the race as well as in the reproduction of the individual. The adequate statement of the evidence upon which this generalization rests, or even a full statement of the generalization itself, with its qualifications, would be out of place here, but the facts which have been given seem to be sufficient to warrant its use as one step in our argument in regard to the relations of the sexes. From this as our basis we will now trace the evolution of sex.

Among the lowest organisms, animal and vegetable, multiplication is usually by the various forms of asexual generation, budding or fission, or cell-multiplication—an organism which has by ordinary growth increased in size beyond the limit of exact harmony with its environment, dividing in this way into two, like each other as well as like their parent. In this way the preservation of the established characteristics of the species—heredity—is provided for, but in order that progress should take place, by the preservation of favorable varieties, variation must also be provided for. This is accomplished by the process which is known as conjugation : two protoplasmic organisms approach, come into contact, and a transfusion or mixture of the

semi-fluid contents of their bodies takes place. The result of this process is the production of new individuals which, deriving their protoplasm from two parents which are not exactly alike, are themselves different from either of them, and have individual peculiarities which are, it is true, the resultant of the peculiarities of the parents, but which are nevertheless new variations.

In the simplest forms of conjugation the functions of both parents appear to be identical, but in organisms which are a little more specialized we find male and female reproductive bodies, and the offspring is the result of the union of the male element of one individual with the female element of another; that is, we have true sexual reproduction in its simplest form.

Among the lower animals and most plants both sexes are united in the same individual, but the law of physiological division of labor, the principle that an organ or organism, like a machine, can do some one thing better and with less expenditure of force when it is specially adapted to this one thing than when it is generally adapted for several functions, would lead to the preservation by natural selection of any variations in the direction of a separation of the sexes, and we should therefore expect to find among the higher animals what we actually do find: the restriction of the male function to certain individuals, and the restriction of the female function to others. From this time forward the male is an organism specialized for the production of the variable element in the reproductive process, and the female an organism specialized for the production of the conservative element. We soon meet with structural peculiarities adapted to aid and perfect the performance of these respective functions; and the various organs, habits, and instincts by which, among the higher animals, the rearing of young is provided for form one of the most interesting chapters of natural science. On *a priori* grounds we should expect a still greater specialization to make its appearance. Since the male organism has for its function the production of the variable reproductive element, and since variations which originate in a male have their perpetuation especially provided for, it would clearly be of advantage that the male organism should acquire a peculiar tendency to vary, and any steps in this direction would accordingly be seized upon by natural selection and perpetuated. The female organism, on the other hand, having for its function the transmission of the established hereditary features of the species, we should expect the female to gradually acquire a tendency to develop these general characteristics more perfectly than the male. The male organism would thus gradually become the variable organism, as well as the transmitter of variations, and the female organism would become the conservative organism, as well as the originator of the conservative element in reproduction.

The study of the higher forms of life shows that this specialization

has actually taken place in many cases, and that, in nearly all cases in which the sexes differ in peculiarities not actually concerned in reproduction, the male has varied more than the female. The amount of variation which any organism has lately undergone may be learned in two ways—by a comparison of allied species, and by a comparison of the adult with the young. In a genus which comprises several species the characteristics which these species have in common are due to heredity from a common ancestor, and are therefore older than features which are confined to any one species. Now, it is a well-known ornithological law that the females of allied species of birds are very much more alike than the males, and that in some cases where the females can hardly be distinguished the males are very conspicuously different—so much so that there is not the least danger of confounding them. Countless examples will present themselves to any one who is at all familiar with birds, and those who are not can at once find ample proof by glancing through any illustrated work on ornithology —Gould's "Humming-Birds," for example.

The greater variability of the male is also shown by a comparison of the adult male and female with the immature birds of both sexes. Since the growing animal tends to recapitulate, during its own development, the changes through which its ancestors have passed, substantially in the order in which they first appeared, it follows that, in cases where the sexes are unlike, the one which is most different from the young is the one which has varied. Now, it is only necessary to compare the nearly full-grown young of our domestic fowls with the adult cock and hen, to perceive that the adult hen agrees with the young of both sexes in lacking such male characteristics as the highly ornamented tail-feathers, the briliant plumage, the distended comb, the spurs, and the capacity to crow. Countless similar illustrations might be given to show the great tendency of the male to vary, but the above are sufficient for the purposes of our argument. As both sexes usually retain the more general specific and generic characteristics, and are alike as far as these are concerned, it is a little more difficult to show the conservative constitution of the female than it is to prove the male tendency to vary. Among the Barnacles there are a few species the males and females of which differ remarkably. The female is an ordinary barnacle, with all the peculiarities of the group fully developed, while the male is a small parasite upon the body of the female, and is so different from the female of its own species, and from all ordinary barnacles, that no one would ever recognize, in the adult male, any affinity whatever to its closest allies. All of the hereditary race characteristics are wanting: the limbs, digestive organs, and most of the muscles and nerves have disappeared, as they are not needed by a parasitic animal; and the male is little more than a reproductive organ attached to the body of the female. It is only when the development of the male is studied that we obtain any proof of its

specific identity with the female. The young of both sexes are alike, and the developing male shares with the female the characteristics which unite them to the other barnacles, and which are due to descent from a common form. The female keeps these hereditary characteristics through life, while the male soon loses them entirely.

These facts seem to be sufficient to prove that the specialization which we should expect to find among the higher animals with separate sexes does exist, and that the male organism is especially and peculiarly variable, and the female organism especially and peculiarly conservative.

Leaving this aspect of our subject for the present, let us look at it from a somewhat different point of view. The history of the evolution of life has not only an objective side, but something which may with perfect propriety be spoken of as a subjective aspect. The progress which is shown objectively as greater and greater specialization of structure, and a closer and closer adaptation of the organism to the conditions of the external world, has been well described by Herbert Spencer, as the increasing delicacy, exactness, and scope of the adjustment between internal and external relations. Seen in its subjective aspect, each of the steps in the growth of this adjustment is a recognition of a scientific law, the perception of the permanency of a relation between external phenomena; for science is simply the recognition of the order of nature.

When a Rhizopod discriminates between the contact of a large body and that of a small one, and draws in its pseudopodia and shrinks into as compact a shape as possible in order to escape the danger which the past experience of the race has shown to be related to the former sensation, or when it expands its pseudopodia in order to ingulf and digest the body which has caused the second sensation, it furnishes proof that its scientific education has begun. Of course I do not intend to say that the order of nature, according to which the Rhizopod adjusts its actions, is consciously apprehended, but simply that it is the experience of the existence of this order which determines the action. Throughout the whole course of the evolution of one of the higher organisms each variation which served to bring about a closer harmony between the organism and its environment, and was accordingly preserved by natural selection, and added on to the series of hereditary structures and functions, was in its subjective aspect the experience of a new external connection, a new step in the recognition of natural law, an advance in scientific knowledge. Human advancement is of course widely different from the slow progress of the lower forms of life, but it is fundamentally the same. Experience is continually spreading over new fields, and bringing about a more wide and exact recognition of the persistent relations of the external world. The scientific laws thus recognized then gradually take the shape of principles or laws of conduct, according to which actions

are determined in those cases where experience has shown that they apply. Those laws of conduct which have been long recognized gradually assume the shape of habits or intuitions, according to which conduct is almost unconsciously regulated, and the habits finally become established as one of the hereditary characteristics of the race.

We are apt to confine our attention to the subjective side of human advancement, and to neglect the structural side, and at the same time to neglect the subjective side of the evolution of the lower forms of life, and to confine our attention to the structural side, but of course no one can doubt that a new habit is represented by a new specialization of structure, and is transmitted like any other peculiarity by heredity.

If this is so, and if the female organism is the conservative organism, to which is intrusted the keeping of all that has been gained during the past history of the race, it must follow that the female mind is a storehouse filled with the instincts, habits, intuitions, and laws of conduct which have been gained by past experience. The male organism, on the contrary, being the variable organism, the originating element in the process of evolution, the male mind must have the power of extending experience over new fields, and, by comparison and generalization, of discovering new laws of nature, which are in their turn to become rules of action, and to be added on to the series of past experiences.

Our examination of the origin and significance of the physiological differences between the sexes, and of the parts which they have taken in the progress of the past, would therefore lead us to expect certain profound and fundamental psychological differences, having the same importance; and it will be interesting to examine what these intellectual and ethical differences are, and how far experience and the common consent of mankind accord with the demands of our hypothesis.

If, as we suppose, the especial and peculiar function of the male mind is the expansion of our circle of experience; the more exact apprehension of all our relations to the external world; the discovery of the laws of thought, of society, of physiology, and of the material universe, and of the bearing of these laws upon individual conduct—it will follow that men must excel women in their power to discover the manner in which a new external relation shall be met and provided for by a new internal adjustment. In a case where our instincts, intuitions, feelings, or past experiences furnish no guide to conduct, the judgment of a man as to the proper course of action will be of more value than the judgment of a woman.

On the other hand, only a very small proportion of our actions are directed to new conditions; experience has already determined the proper conduct in all the circumstances upon which our preservation and well-being most directly depend; and action in these circumstances does not demand comparison and judgment, while it must usu-

ally be so prompt as to forbid deliberation or thought. The power of quick and proper action in the innumerable exigencies of ordinary life, independent of reflection, is at least equally important with the power to extend our field of rational action.

By the former power we hold on to what has already been gained, while the latter power enables us to increase our advantage in the struggle for existence, and to widen our control over the laws of nature. Psychological variation is the result of the latter power, psychological heredity the result of the former, and psychological evolution and human progress the result of their combined action.

If the female mind is especially rich in the fruit of this past experience, we should expect women to excel men in the promptness and accuracy with which the conduct of ordinary life is decided, and in the range of circumstances over which this power of rational action without reflection extends; that is, we should expect men to excel in judgment, women in common sense.

This important and fundamental difference between the male intellect and the female must have a very great influence in determining the occupations or professions in which each sex is most likely to succeed when brought into fair competition with the other sex.

The originating or progressive power of the male mind is shown in its highest forms by the ability to pursue original trains of abstract thought, to reach the great generalizations of science, and to give rise to the new creations of poetry and art. The capacity for work of this character is of course very exceptional among men; and, although history shows that it is almost exclusively confined to men, it must not enter into our conception of the ordinary male mind. The same power of originating and of generalizing from new experiences is possessed, in a lesser degree, however, by ordinary men, and gives them an especial fitness for and an advantage over women in those trades, professions, and occupations where competition is closest, and where marked success depends upon the union of the knowledge and skill, shared by competitors, to the inventiveness or originality necessary to gain the advantage over them.

Women, on the other hand, would seem to be better fitted for those occupations where ready tact and versatility are of more importance than the narrow technical skill which comes from apprenticeship or training, and where success does not involve competition with rivals.

The adequate examination of this aspect of our subject would furnish material for a treatise, and it is out of place here, as all that is necessary for the purposes of our argument at present is to point out the difference, and to show that it is the necessary consequence of our view of the manner in which sex has been evolved: that it is not due to the subjection of one sex by the other, but is the means by which the progress of the race is to be accomplished.

[*To be concluded next month.*]

SELECTING A FIRST MERIDIAN.*

By E. CORTAMBERT.

EVERY one knows that what is called a *first meridian* is the circle from which we start in reckoning longitudes. It were better to call it an *initial meridian*, or *zero meridian*, for the *first* meridian is not in reality this one, but the first we meet in longitude starting from zero, i. e., at sixty minutes from this starting-point. We should prefer to adopt the term *mediator*, as proposed by M. Bouthillier de Beaumont, it being analogous to the term *equator*, which is the starting-point in reckoning latitudes.

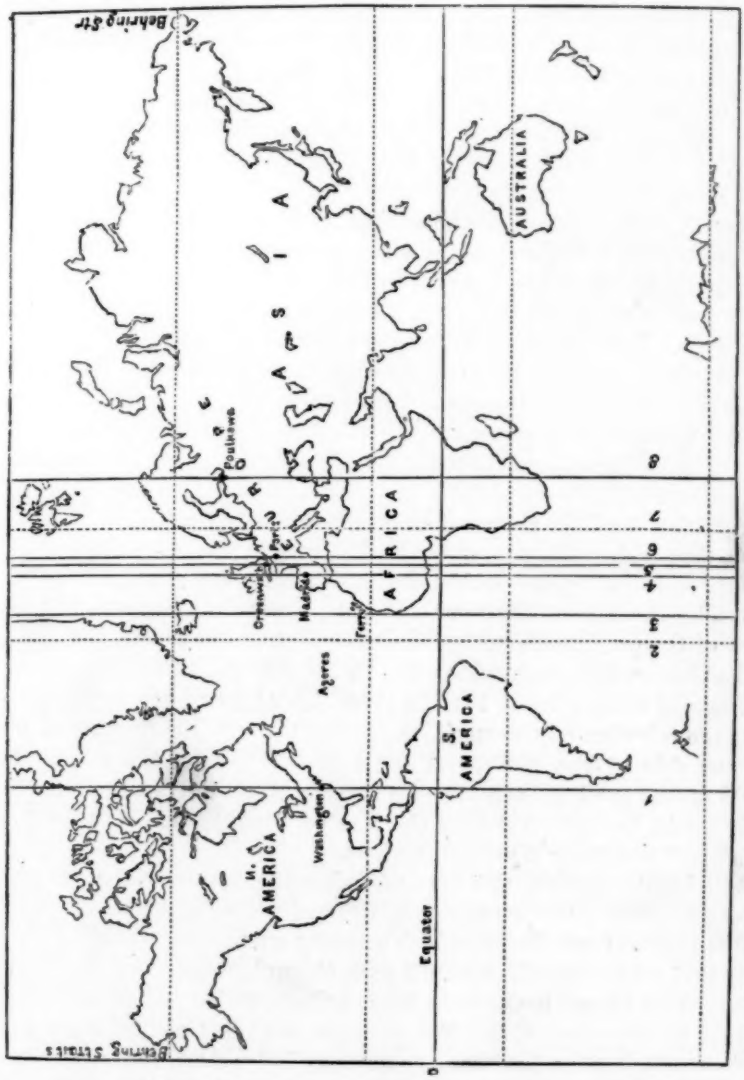
This matter of a first meridian gives rise to very grave complications. Each nation wants to have its own meridian passing through its capital city, or its principal observatory. Hence result numerous difficulties, errors, even dangers and accidents to ships, in case we are not sure about the meridian employed, or if we are in error in our reckoning of the difference between one meridian and another.

The geographical knowledge of the ancients extended on the west only as far as the Canary Islands. From here, or hereabout, Ptolemy started in reckoning longitudes, going eastward to the limit of the countries then known. This western limit of his geographical knowledge he reckoned to be 60° west of Alexandria—a calculation which would place the starting-point a little to the west of the Canaries. According to Ptolemy's geography, Paris is in longitude 23½°, and hence the starting-point could not be the most westerly isle of the Canary group, as has usually been supposed, but farther to the west. Nevertheless, to do away with all uncertainty, an ordinance of Louis XIII., in 1634, declared that French geographers must start from the isle of Ferro. But what was the precise situation of this isle? It was at first held to be 23½° from Paris, and this erroneous calculation has given rise to strange variations in the position of the first meridian in a great number of maps.

In 1682 the observations of Varin and of Deshayes gave the longitude of Ferro as 20° 5′ west of Paris, and thenceforward the round number of 20° was taken to be the distance between these two meridians. Still many geographers, among them Delisle himself, who had been one of the first to make known the precise longitude of Ferro, continued to reckon the distance at 23½°, after Ptolemy. Sometimes they corrected this reckoning, reducing it to 22½°, or even to 20½°. In 1711, in a map of the Île de France (Mauritius), Delisle places Paris in longitude 20° exactly, but the same geographer by a very strange anomaly, in a map bearing date 1717, adopts the figure 22° 30′. In fact, it

* Translated from "La Nature," by J. Fitzgerald, A. M.

was not till the middle of the eighteenth century that, chiefly through the influence of D'Anville and the Cassinis, the precise difference of 20° was definitively adopted. The well-earned fame of the French geographers gave to their determination authority throughout Europe, and



FIRST MERIDIANS.—1, Washington; 2, St. Michael; 3, Ferro; 4, Madrid; 5, Greenwich; 6, Paris; 7, Bouthillier de Beaumont's; 8, Poulkowa.

all the nations accepted this distance and the meridian of Ferro, except England, which fixed her first meridian at St. Paul's in London, and later at Greenwich. In France the meridian of Paris came to be reckoned as first meridian from the publication of Cassini's map. The

first important maps, besides Cassini's, which adopted the Paris meridian were that of Capitaine (1789), and that of De Belleyme (1791).

This over-patriotic selection by the English and French was a bad precedent. The Low Countries must have their meridian at Amsterdam, the Spaniards at Madrid (having previously tried Teneriffe and Cadiz), the Portuguese at Lisbon, the Russians at the Poulkowa Observatory, the United Sates at the Washington Observatory, the Chilians at Santiago, the Brazilians at Rio de Janeiro, and so on.

These divers pretensions are deplorable, and cause no end of confusion, and it is time that a single meridian were established. M. de Chancourtois, in his "System of Geography," which was presented to the Paris Geographical Society in 1874, proposed to adopt the meridian of the island of St. Michael, in the Azores, which he holds to have been Ptolemy's first meridian; which was the meridian adopted by Mercator; and which to him appears to be preferable to all other meridians because it traverses the ocean throughout one-half of its length, and in the other half only touches the eastern extremity of Asia, thus constituting a sufficiently exact dividing line between the two main continents, the old and the new. The late M. Henri Longpérier proposed a meridian traversing the center of Europe, crossing Dalmatia and the Adriatic, and pretty accurately dividing the Eastern from the Western world.

Again, it has been proposed to establish the first meridian at Jerusalem, that center of high and honored memories; but perhaps, just on account of the religious associations, such a selection would not be approved by all nations. For our own part, we confess that we are partisans of the project offered by M. Bouthillier de Beaumont, President of the Geneva Geographical Society to the International Congress of Commercial Geography at Paris in 1878. This learned geographer proposes the selection of the meridian passing through Behring Strait on the one side of the globe, and 10° east of Paris on the other. It would on the one hand separate the two great continents, and on the other would in Europe follow the line of demarkation between the "Eastern" and the "Western" nations.

We highly approve this idea of fixing the first meridian exactly 10° east of Paris: the conversion of determinations of longitude reckoned from Paris and Ferro—which are very numerous—would be thus facilitated. This meridian would pass through Venice and would be very near to Rome, both places dear to the historian and of profound interest to the geographer. Nevertheless, we must not take for the starting-point a place belonging to any particular state, for fear of exciting again those national rivalries which have led to the fixing of such a number of national meridians. But the *mediator* which we propose, in unison with M. Bouthillier de Beaumont, passes also through the island of Levanzo, off the west coast of Sicily. Might not the Italian Government cede this islet to the world of science, to form the site

of a central and international observatory? The place might be the common property of all the civilized nations which might agree to its acquisition; for, we repeat, it must be neutral ground, a position independent of all political power, and under guarantee of all the states of the civilized world. The 180th degree would traverse Cape Prince of Wales, where it projects into Behring Strait, and this and the island of Unalashka in the Aleutian Archipelago are the only points where it would touch land. The United States, following the example of Italy, might cede to the republic of science this cape or a part of Unalashka, to be the site of an observatory in correlation with that of Levanzo.

THE STUDY OF PHYSICS IN THE SECONDARY SCHOOLS.

By JOHN TROWBRIDGE,
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PHYSICS is a comprehensive term for the laws of the physical universe, and is gradually superseding the old term natural philosophy which held together in a disconnected manner various facts in mechanics, light, heat, sound, electricity, and magnetism. Under the head of Natural Philosophy most of us were taught that a body falling from the vertex of an inclined plane acquires the same velocity as it would if it rolled down the plane. A considerable knowledge of mathematics was required to prove this fact, and the youthful mind could hardly see the bearing of it when it was demonstrated. We were shown what we learned to call the falling machine of Atwood, which proved simple laws with such ponderousness of structure and complexity of appliances that even the name of the machine made more impression upon the memory than the laws of which it was the servant. The brightest boys could prove that the square of the velocity of a falling body was equal to twice the acceleration of gravity multiplied by the height through which it had fallen, and the rest of us mutely followed the rule, and substituted in a formula which was forgotten as soon as the exigencies of school life were over. We also carried away vague recollections of a pump which worked by means of a curiously constructed valve. We had forgotten whether the center of gravity is where the center of pressure is applied, or where specific gravity exerts itself. We remembered a tuning-fork, an electrical machine, and a big electro-magnet which lifted the smallest boy in school, and that was all that we remembered of natural philosophy. At that very age most of us, if not all, were curious about air and water, the motions of the earth and the moon, the light of the stars,

the curious manifestations of frost, fire, and electricity and magnetism. I remember how glibly we recited portions of natural philosophy where the author forgot his grim mood for a moment, his triangles and square roots, and explained in a simple manner why the rising moon appeared so large between the small branches of a wood, and why fog came up the bay when the sun went down. When we succeeded in getting the right answer to a problem we were elated and began to think that natural philosophy was not so difficult to study, after all; but these moods of elation were too often succeeded by those of blackest night and incendiary desires. In looking back, the thought comes to us that there must have been something radically wrong in such teaching; for the subject of the laws of the physical universe has such infinite possibilities and contains so much that can stimulate the imagination of even young children, that any method which represses, or does not encourage a child's desire to know the reason of things, must be radically wrong.

It must not be supposed, however, that the picture we have presented has not its bright side: there are always teachers who are especially interested in physical science, and who excite an interest in the subject among their pupils. The hour of the lecture on physics is looked forward to by the pupils of some schools with great relish, and some date their interest from the school exercises in this branch. Generally speaking, however, most men who have more than the ordinary knowledge of science have had their enthusiasm awakened out of school, and by actually working with apparatus, or handling specimens, have taught themselves.

The opponents of the study of physics in the secondary schools generally regard it as of less importance than the mathematical or grammatical studies, and class it among what they regard as superfluous subjects, the number of which has very much increased of late years. Not a few of these remember the manner in which they were taught, and have no desire that their children should repeat their experience. It is very natural also that the teacher whose training has been exclusively literary should be indisposed to teach a subject like physics, which requires a certain facility with apparatus and some inventiveness which a purely literary training has the effect of obscuring and even crushing out. Who has not seen an excellent teacher in the languages or even in mathematics fail completely before a class of boys and girls in showing some simple experiment? It is very natural that he should fail, for this facility and inventiveness of which we have spoken come, except to the few, only by practice and from an early habit of observation. More time also is consumed in getting ready for one lecture or exercise in physics than in six recitations in the straightforward subjects of language and mathematics. A refractory piece of brass, a wire wanting here and there, a shrunken bit of bladder, a broken glass tube, may involve hours' labor for one who is gen-

erally hard-worked in other ways. It is easy to theorize on the subject of teaching science, especially physical science, in the second grade of schools, but one should not forget the wearing nature of routine work which is apt to deaden one's enthusiasm. One can not expect a teacher to hold weekly talks with his pupils on force, or to rely upon treatises which are merely descriptive, or to be patient with apparatus which, by frequent use, seems almost puerile, without giving him also a comparatively rigid standard in the shape of a book by which he can advance in a more or less mechanical manner. Many teachers, therefore, comply with the letter of the law, and with one of the many text-books called Natural Philosophy shorten the popular exposition of the subject to a minimum and demand a certain number of problems under the lever, the screw, the inclined plane, and the pendulum. This mechanical teaching succeeds to a certain extent with the bright boys of some methematical tendencies; but it fails with the great majority, who speedily get a disgust for the whole subject. To add to the teachers' difficulties, many of them have not a sufficient knowledge of the subject to enable them to courageously reject the descriptions of machines with which many text-books are filled, in which the principles are lost sight of in a multiplicity of levers, pulleys, and connecting pieces.

In teaching a language or a branch of mathematics in a grammar school, one has all his materials ready at hand, a certain author, a certain dictionary, a grammar. In teaching physical science, almost every text-book requires to be supplemented by some apparatus which is not provided with the text-book, and contrivances must be resorted to, and judgment must be used in regard to aids in teaching upon which experience seems to be very indefinite. There are wide limits in regard to the cost of this or that piece of apparatus, and difficulties in deciding between instrument-makers. Very often there is no one available to repair an instrument, and the instruction has an added tendency to become mechanical.

On the other hand, there are enthusiastic teachers who are imbued with the modern popular method of teaching physics by the aid of a lime-light stereopticon. Small appropriations are saved until an expensive instrument can be obtained; and what may be called a college course in physics is inaugurated in the second grade of schools. It is a laudable ambition to desire to illustrate the subject of physics by the method of projections; but the policy of expending from one to two hundred dollars for a lime-light for the use of a grammar or even a high school is questionable.

Professor Mayer, in his excellent little books on the experimental study of light and sound, shows how a water lantern can be constructed for three dollars, which answers every purpose; and if there is no sunlight one of the many forms of kerosene lanterns is admirable for showing diagrams, the deflections of a galvanometer, crystallizations, and minute experiments which a class could not otherwise see

to advantage. With the aid of such a cheap method of projection, a grammar-school master can give quite an extended course in physics with simple apparatus. He can draw his own diagrams on smoked glass, fixing the drawing by exposing it to the vapor of alcohol, which is evaporated from a shallow dish; and for the money which is expended for a lime-light apparatus enough apparatus can be bought which, supplemented by a water or a kerosene lantern, would illustrate a full course of elementary lectures on physics. In many school collections of apparatus, a few expensive instruments will be found: an air-pump; a Holtz electrical machine; a large induction coil. One or two of such instruments form the rallying point of the department of physics, and are accompanied by meager and disjointed apparatus. The student collects, so to speak, his thoughts about the picture of a complicated machine; his ideas of the pressure of gases or rarefied air are complicated by the imperfect remembrance of certain valves. Electricity of high tension means something evoked by an electrical machine. These pieces of apparatus which I have mentioned form a salient point of attack upon the system of instruction in physics too common in many schools. A good air-pump is difficult to keep in order, and finds its true place only in the private laboratory of an investigator, or in a college collection of apparatus. In the secondary grade of schools some form of Sprengel's pump, or, where there is an available head of water, an aspirator, will illustrate varying pressures sufficiently well. The new Holtz machine which schools are anxious to possess can only serve as a toy, for the theory of its working is very hard to comprehend even by those who have studied the subject in mature years.

The modern view of the physical universe is that there is no such state as rest: the particles of a gas are in an incessant state of motion, and it can be maintained that when a stone rests upon a table it is not at rest; for it is forced downward by the action of gravitation through a very small distance, and the elasticity of its support tends to move it upward through the same distance. The term statics is apt to be misleading, and the best writers on science of to-day begin treatises on natural philosophy with the subject of dynamics or forces in motion. In no subject, however, is the division into statics and dynamics so illogical as in the subject of electricity. In most schools a student begins the study of this subject with frictional electricity and the electrical machine. An advanced student in a university pursues the opposite plan, and approaches the subject, even if it be for the first time, from the standpoint of the voltaic cell, and traces the development of the force up to the point of the generation of electricity similar to that produced by an electrical machine. Very little knowledge can be obtained from the exhibition of toys like dancing pith-balls, insulated stools, miser's plates, and apparatus for obtaining shocks.

The method of instruction in physical science, therefore, in the secondary grades of schools, seems to me to be too costly and not sufficiently logical. The remedy does not consist in curtailing the amount of attention paid to the subject in the lower schools, or in relegating it to a more advanced period of education. It is more reasonably embraced in leading teachers to seek simpler methods of instruction, simpler apparatus, and to avoid abstruse conceptions, and the solution of mechanical problems for which mere formulas are given. It would be well, also, if the best students are led to experiment themselves, and are stimulated to observe. This is hardly possible in crowded grammar schools; but the excellent little treatises of Professor Mayer on experimental physics would lead many children, under proper encouragement from their teachers, to try simple experiments at home.

An ideal method of teaching physics in the secondary grade of schools would consist in developing the whole subject from the standpoint of motion, insisting upon the larger facts, correlating them as far as possible, and neglecting special applications and special facts. A number of interesting experiments can show that work must be done in all cases to produce work, and that motion can be changed into heat, and heat into motion. The student's mind should be tempted to take, at the very beginning of his study of the subject, an extended view of the application of the law of the conservation of energy. While treating the subject of force, a little descriptive astronomy can be given which will aid in stimulating the imagination. The subjects of heat and acoustics can be taught purely under the head of mechanics, with a variety of most interesting and simple experiments. I am inclined to place the subject of electricity and magnetism under the same head; and, beginning with the fact that electricity is generated by a voltaic cell, I should trace its simple manifestations until they conduct one to the law that all motion can be converted into electricity, and that electricity can be entirely converted again into heat and light. Having then shown that light can be produced by motion, the undulatory theory can be cautiously introduced. As a review of the subject of physics, one could take as a text the impossibility of perpetual motion, and enforce it with a variety of illustrations. The utility of the study of physics in the grammar schools is often questioned, and indeed the larger question of the value of scientific training except to the few in the world at large is often mooted. There is no doubt that the study of the humanities, in which the great story of men's deeds in the past is recorded, will always prove the most fascinating to the majority; and it can be maintained with reason that those subjects which readily excite an interest in the largest number will prove the readiest means of intellectual training. Science is regarded by many scholars merely as a practical branch of human knowledge, and, although its great value in contributing to the good of the world is acknowledged, yet

its study is regarded as inferior in intellectual results to that of language or philosophy. It can not be denied, however, that the study of physical science gives a certain definiteness to our modes of thinking, even if it will not be granted that it affords a better method of intellectual training than philological study. It supplies a tonic which minds much accustomed, from the exclusive study of language, to take things for granted and to look no further than the grammar and dictionary stand much in need of, and also corrects a certain credulity and superstition which is rampant even in our time, and to which it is well to devote a few words in connection with the subject of scientific training. There is a strong undercurrent of superstition and belief in supersensible or wonderful and not-to-be-explained marvels which makes its way beneath the crust of society. Occasionally it bursts forth in so-called manifestations of spiritualism and animal magnetism, or belief in mesmerism and clairvoyance. There is hardly a family of which some member has not applied to a clairvoyant for relief in diseases which the regular practitioner has failed to treat successfully. A literary education does not cope successfully with the insidious advances of this form of ignorance; for the very element of education which can do so is not generally cultivated among even so-called liberally educated persons.. This lost element is the spirit of investigation. The students who come to a physical laboratory for the first time can be rapidly classified into three classes: 1. Those who can reason from A to B over what may be termed a straight line with considerable ease. 2. Those who naturally reverse their process of reasoning and test the way from B to A; this is a rarer class of minds. Copernicus was unable to explain the motions of the planets by supposing that all the visible stars revolved around the earth; he reversed his process of reasoning, and explained the facts by supposing the earth to turn and the stars to remain at rest. Kant, in his "Critique of Pure Reason," speaks of the revolution which he had brought about in philosophy, and likens it to the logical process which led Copernicus to his discovery. "Hitherto," he says, "it had been assumed that all our knowledge must regulate itself according to the objects; but all attempts to make anything out of them *a priori*, through notions whereby our knowledge might be enlarged, proved, under this supposition, abortive. Let us, then, try for once whether we do not succeed better with the problems of metaphysics, by assuming that the objects must regulate themselves according to our knowledge, a mode of viewing the subject which accords so much better with the desired possibility of a knowledge of them *a priori*, which must decide something concerning objects before they are given us." In practical matters this process of reversals is often exemplified; the inventor of the sewing-machine finds that his needle will not work with the eye at one end, and accordingly reverses its position and is successful. 3. The third class comprises those who may be said to think

in directions at right angles to their previous method of thinking, and there may be minds which possess what is analogous to the 4th dimension in space—an ability to think in all azimuths. It is strange that there are so few psychological impostors in the world; for the first class of minds, those who only think from A to B when a new class of facts are presented to them, is very large. An ingenious man can make a small magnetic motor which apparently runs with only the assistance of permanent magnets, and by means of extremely small clockwork maintain the motion beyond the period which a mind of class 1 is willing to give to an observation. It would naturally occur to such a mind to take the motor to pieces and examine the casings or box. If it finds nothing, and perceives that, when the apparatus is put together and is placed by the inventor on his table, it still runs, the investigation ceases, and another story confirms the previous rumor of a new marvel. A mind of class 2 goes over the same process of reasoning, and moves the instrument to different points for fear of concealed mechanism under the table or in the wall. A skillful manipulator, however, can still edge the motor to a third or fourth position, where other concealed clockwork can be taken advantage of, and in this way exhaust the number of what may be termed linear combinations of the investigator. The success of impostors in spiritualism and of the fabricators of new motors which are built to delude people resides in this, that they restrict the liberty of this system of reversals, or the spirit of investigation.

Any plan of education which prevents a man or woman from becoming the dupe of those who pretend to use natural or supernatural forces is to be commended. One of the quickest ways of training the mind in the logical process which I have indicated is to undertake some simple investigation in physics. Here mere observation is combined with a careful study of the interaction of various forces, and the mind must assign a logical weight to different observations. One truth, moreover, is forcibly brought forward—that, generally speaking, a number of observations under varying conditions must be made to prove the correctness of any result. The man who has been through the process will not be found among those who are convinced by a single manifestation of clairvoyance or of spiritualism. He will not spread the stories of a wonderful new motor until he has put it to an exhaustive test.

It would be well if our common schools made some provision for a certain amount of experimental work in physics to illustrate this method of studying. A great deal of education is comprised in the knowledge of how to change the conditions of an experiment in the process which I have termed a reversal, and also in the process of depending only upon a number of observations taken under different conditions. It would certainly be a great boon to the world if the general level of scientific education could thus be raised, so that each

young man or young woman, when he or she issues from school doors, should have enough definite knowledge of the great laws of the physical universe to instantly denounce blue-glass theories and attempts at perpetual motion, not from the pride of knowledge, but from the feeling that error, credulity, and superstition should be combated with truth.

MODERN SCIENCE IN ITS RELATION TO LITERATURE.

By WILLIAM BRACKETT.

THE innovations made by science upon other modes of thought and study within the last half century are without a parallel in the history of human progress. It has swept away many of our most cherished convictions, hoary with the dust of ages, and left others in their places entirely irreconcilable with them. Marching on with the might and majesty of a conqueror, it has spread dismay in the ranks of opposing forces, and caused a complete abdication in its favor of many of those who were most hostile to it. Nor has it taken the field in an aggressive or bellicose spirit. On the contrary, almost all its conquests have been made without any design of inspiring opposition or terror, and while engaged in pursuits that of all others require for their prosecution the most pacific and philosophic temper.

It might be easily shown by the comparison, were this essential to my design, that in the three great departments of human study, namely, those of science, religion, and literature, the cultivators of science have always shown a disposition to be more tolerant of opposition and more lenient toward their enemies than those engaged in either of the other pursuits. It might be shown that religious controversies, and the animosities engendered by them, hold the first rank in the scale of bitterness. Next come those of a literary nature, which, in the last century, were scarcely less implacable; while, with few exceptions, the great problems that have engaged the attention of scientists have been singularly free from heated and acrimonious discussion.

Much of this serene treatment of scientific subjects is due, no doubt, to their peculiar nature. In a given investigation the truth must, sooner or later, come to the light. Either the investigation will have to be abandoned altogether, because it is found to be beyond the province of the human understanding, or the problem will eventually be solved. In either event, long-continued doubt and uncertainty can not hang over the result. Hence few will venture, if so disposed, to cast ridicule upon efforts which may be crowned with success, and which may in the end expose the scoffers to similar reproaches.

Besides, the study of science, which is the study of nature, engages the mind in the study and contemplation of truth; and, as has been well said, "Truth is without passion." The little asperities, therefore, which ruffle other controversial natures, find scarcely any lodgment in the breast of him who searches after experimental truth. And such would be the effect produced upon the students of theology and literature were their conclusions capable of verification like those of the scientist. But, dealing for the most part with abstract subjects which in the nature of things can not be subjected to rigid mathematical tests, they find themselves afloat upon a wide sea of conjecture, in which faith and imagination are almost the only guides.

At this triumphant entry and career of Science upon the stage of modern thought, Religion is the only power that has as yet sounded the note of alarm, or assumed any very hostile attitude. Nor could she well do otherwise, because, one by one, she has seen her adherents falling away from her, and joining the ranks of her ostensible adversary, and, one by one, she has seen some of the fairest portions of her territory invaded, and either falling a prey to anarchy and dissolution, or rudely wrested from her. In vain she has cried out for help, or tried to throw up barriers against this invasion. The sapping and mining process has nevertheless gone on; so that, if in the next half century the progress of science shall make as great inroads upon the prevailing popular belief as it has made within the last, it is safe to predict that only a moiety of it will be left, or, what is more probable, it will be changed into something more consonant with the new scientific discoveries, and with what is called "the spirit of the age."

If the changes thus following in the wake of physical discovery have been so marked and significant upon one of the interesting branches of human knowledge to which allusion has been made, how has it fared with the other, which, if not so widespread in its influences, can not nevertheless be affected in its character or career without producing results of the greatest consequence? Has literature as well as religion felt the wand of the mighty magician? and is it likely, in the future, to be retarded in its growth, crippled in its strength, or to any extent diverted from its purpose by this onward and sweeping march of science? These are questions of so much importance that the candid consideration of them can not be without its interest if not without its profit.

The commonwealth of literature embraces many states and distinct divisions, of which only those are particularly referred to in these pages that are usually comprehended under the title of polite or elegant literature, including works of the imagination, such as poetry and fiction, as well as authentic narratives, set off, as in history, with the graces of polished composition. Limited to even this description, literature has performed such an important part in administering to

the instruction and delight of the world, that we could not afford to see it banished, even though a more efficient teacher should occupy its place. Nor can such a fate now in reality overtake it. Even should the number of its votaries ever be diminished, or should it ever fall into hands too feeble to sustain it, we would still have access to the ancient well-springs of its power, whose waters, though incapable of extension, can yet never run dry. It is a consolation to know that, though it may be impossible to add anything of sterling value to what has already been written, the great works of literary genius, treasured up in so many different languages, can never be taken away from us, and that their influence survives the manifold changes that happen to society in so many other respects.

Now, if it be true—that complaint of Labruyère—that "we are come into the world too late to produce anything new, that nature and life are preoccupied, and that description and sentiment have been long exhausted"; if it be true that literary labor, in times past, has spent itself in producing those wonderful creations which, by the common consent of mankind, stand as the highest models of composition and the highest types of literary excellence, then we must conclude that literature has reached its climax and fulfilled its mission, and that consequently there is no reason to regret its decadence. Better employ the measure of strength and talent with which we are endowed in exploring new lands and cultivating new soils than waste them in a field that is already gleaned of its harvests and exhausted of its fertility. To such a gloomy view of the present condition and future prospects of literature many men of sound judgment are unwilling to subscribe. And yet it seems to me, if they carefully consider the subject, especially in connection with the new direction which has been given of late years to the studies and aspirations of the noblest minds, they must see good reason for modifying their judgment. Let us examine it for a few moments with respect to two of the departments of letters that are regarded among scholars at least with the highest esteem and veneration of any—I mean poetry and history.

Those who are most familiar with the poetry of different countries, and of ancient and modern times, must admit the remarkable resemblance and repetition to be found in it. Under the garb perhaps of a new diction, in one poet, will be found lurking the identical idea expressed by another. As Emerson says: "The originals are not original. There is imitation, model and suggestion, to the very archangels, if we knew their history. The first book tyrannizes over the second. Read Tasso, and you think of Virgil; read Virgil, and you think of Homer; and Milton forces you to reflect how narrow are the limits of human invention." And as Dryden somewhere says about the modern poets, "You may track them in the snow of the ancients." Even the imagery and what is called the "machinery" of poetry repeat themselves in different ages, in the pages of different writers. The

only difference is in the language—the thought remains a constant quantity, being stereotyped and reproduced to suit the emergency.

Now, this perpetual recurrence of the same idea among different poets is often stigmatized as plagiarism. But such a charge is not necessary, and is, I believe, in the majority of cases, entirely without foundation. A man gifted, or who imagines himself gifted, with the power of composing verses, and who has read with care and attention the great masters of the art, will insensibly reproduce many of their best thoughts. Yet such a man is not a plagiarist. He is, at the worst, only an imitator, and an unconscious imitator at that. And for this reason, if not for the one Aristotle gave, poetry may be called emphatically an "imitative art." But there is a still higher reason why one poet should become, as it were, the echo of another; and that is to be found in the nature and limitations of the human mind itself.

The maxim, *Poeta nascitur non fit*, is the true expression and interpretation of the law which governs the poetical order of intellects. At rare intervals, Nature has sent into the world a few souls endowed with the largest possible measure of ideality and poetical power. Their number may be counted upon one's ten fingers. Inspired with song, this gifted few can not choose but sing. They are the leaders of the choir; while all the rest are but subordinates, obeying the heaven-born impulse given to them by the muses' elect. As well might the mocking-bird essay the highest and sweetest notes of the nightingale, or the fledgling try the eagle's flight, as one of the non-elect aspire to reach the heavenly harmony of these natural minstrels and apostles of song. Such men as Homer, and Dante, and Shakespeare, constitute the grand natural hierarchy of genius, to which inferior minds instinctively pay homage, and before which they "pale their ineffectual fires." These are the great central lights of poetry, while all the rest are the little miniature worlds revolving around them, and really borrowing from them all their effulgence. Hence we ought not to be surprised to find nothing in the lesser luminaries which the greater do not contain. It is in the order of nature, which it were vain to attempt either to resist or reverse.

Thus the task being almost hopeless of trying to achieve any lasting distinction or success in a field already preoccupied, and incapable of further profitable cultivation, many of the most gifted intellects, in our day, are diverted from it by the greater prospect of reward held out by science, whose territory is vastly more extensive as well as prolific. It were easy to name more than one man eminent in science, whose natural gifts would qualify him to shine in the lists of poetry, and yet who has wisely chosen the path leading to higher honor and remuneration. Hugh Miller might have stood high among the Scottish bards, had he devoted himself to the muses with the same ardor and enthusiasm with which he grappled some of the profoundest ques-

tions in geology ; and with how much more of justice might that line of Pope—

How sweet an Ovid Murray was our boast!—

have been applied to Tyndall than to Lord Mansfield, had Tyndall also cultivated the muses! And yet it is safe to say that neither Hugh Miller nor Tyndall, by rivaling some of the first poets of the day, would have acquired as much honor, and, what is of far more importance, would have been of as much service to the world, as in filling so worthily and performing so honestly the respective spheres of scientific labor assigned to each of them.

Besides opening up such an avenue to men of real genius, the pursuit of science, when properly understood, is far more attractive and more in harmony with their tastes than can possibly be the cultivation of an art already touched by the hand of decay, and passing into the limbo of faded and effete systems. In the pursuit of science we go in quest of natural laws that there is every reason for believing are almost innumerable and inexhaustible ; in poetry, the search is for phantoms of the imagination which, ten to one, have already flitted across other minds and been appropriated by them. In science, we search for the real, oftentimes more wonderful and beautiful than the most splendid visions ; in poetry we search for the ideal, which, if it be new, now almost impossible, fails to command admiration, unless it be set before us in the most pleasing colors, and in a style of the highest finish. This elaborate toilet being unnecessary, though admissible to some extent in the treatment of scientific subjects, more range is given to the reason and less to the discursive faculties. And herein lies one of the chief advantages of the scientific method. While giving sufficient rein to the imagination to keep it in healthy exercise, it makes use of the reflective and perceptive powers in an eminent degree. Hence it engenders the greatest strength and breadth of the intellect ; and it is no exaggeration to say that, if all other methods were abandoned, the study of science alone is capable of raising the mind to the loftiest possible standard of development.

Sooner or later educational institutions must take notice of this fact, and give it the heed its vast importance deserves. It seems impossible that a few narrow-minded patrons and disciples of the old system, watching at the gates, should much longer shut out from our seminaries of learning that great herald of freedom, of reform, and of progress, panoplied in the armor of truth, who has already dethroned so many idols of the forum, the pulpit, and the market-place, and who stands ready, on entering these seminaries, to perform a similar lustration. And nothing needs it more. Palsied almost by a *régime* which administers public instruction on pretty much the same plan upon which wars are conducted in some of the countries of the Old World—that is, without adopting either the new discipline or the new arms

which have enabled other countries to achieve victories—our system of public schools is sinking into decrepitude and decay for want of a new stimulus. Give it this in the shape of lessons in modern science, in all its freedom and amplitude, and it will be infused with new life. Give it this, and the education of our youth will be something more and something higher than injecting into the mind several new languages, to the sad neglect of the mother tongue, and loading the memory with a useless mass of rules, and definitions, and other abstract forms, which are forgotten as soon as the student enters upon the stage of practical life.

But to return from what may seem a digression. The influence exerted by the march of modern science upon history and historical composition is even more direct and decided than its influence upon poetry. Dealing with the actions of man either in his individual or collective capacity, even the best historians have been in the habit, until within a few years past, of regarding them as the result either of self-directed will or of special providences. Consequently their pages are filled with the marvels wrought by heroes and conquerors, particularly those who were regarded as the especial favorites of Heaven. No margin has been left in these pages for the operation of general laws, guiding and controlling human conduct. And it is only within a recent period that the theory has been formulated that the progress of society is not to be attributed to the casual disturbances made by powerful individuals, or to the ascription of supernatural means, but wholly to the force of laws working out their results without the interference of either divine or human agency. This contribution, or rather new direction to history, constituting by far its most essential feature and element, we owe to science. A few great minds, chief among whom may be mentioned Comte in France and Herbert Spencer in Great Britain, taking their stand upon the recognized principles and harmonies prevailing in the material universe, have transferred this grand conception of law and order amid apparent discordances into the sphere of human societies. Here, as well as in the material universe, the relations existing between different communities, and between the individual members of each, are relations due to the interaction of natural forces; and here, as well as in the material universe, the changes that have been wrought out by these forces are changes analogous to those we see exhibited in the consolidation of the crust of the earth, and in the genesis and growth of the solar and stellar systems—changes, that is to say, from a state of homogeneity to greater and greater complexity and apparent elaboration of detail.

Now, this evident leaning of historians, in common with almost every other class of writers, at the present day, toward the theory of evolution, is so great, and so much is expected of them on account of this theory, that if they were practically to disregard it, in writing history, they would be almost left without readers. I might go further,

and say that the tendency to connect the facts of history with the overruling operations of law is fast breaking down the barriers which separate our views of the government of the material world from those we hold concerning the affairs of man; so that it is safe to predict that the time is not far distant when, in a philosophical point of view, no very perceptible difference will be seen between the forces which control the conduct and career of nations and those which preside over the movements and revolutions of planets.

In view of this overshadowing influence, it were useless to touch upon the minor disturbances which science is producing upon history. It may almost be described as the grand motive power, which, in our day, is dragging the car of history along with it, as it drags all the rest in the train of literature. Whether they are the luxurious palace-cars, like poetry and history, furnished with all the elegance which man's inventive genius has been accumulating for centuries, and which only the richly-endowed may enter, or whether they are the plainer passenger-cars, like fiction and eloquence, filled with a group of motley characters, of greater or less pretensions and importance, and tricked out in a variety of costumes—they are all whirled along over the same road, obedient to the impulse given them by the mighty machine which stands, or rather flies, at the head of the train.

The highest aim of science is to discover the truths of nature. Literature, aspiring to something similar to this, recognizes the highest merit of literary composition in what is called its "truth to nature." In delineations of character, in descriptions of scenery, in the skillful weaving together of the component parts of a play or a novel, in the birth of sentiment, or in the happy turn given to an expression, what we most admire is the writer's adherence to certain rules or standards that have the closest conformity with what we observe in the internal or external worlds. From what we perceive in ourselves or in things around us, we derive the measure and gauge of all literary excellence. True, our own perceptions are trained and quickened by the thoughts and perceptions of others; so that what we read or hear aids us in correcting, enlarging, or refining our literary judgments. But we must be able to combine empirical tests with subjective analysis, before the intellectual process can be completed which authorizes us to determine whether any given production reaches that highest grade of excellence implied in its being "true to nature." But what, it may be asked, does this truth to nature actually consist in? Is it necessary that the author should set before us something that really exists?—something to be seen in nature, like a tree or a waterfall? Do we require of him an absolute verity? So far from this, it is only necessary that he should not shock us with anything that, at first sight, is repugnant to our tastes or feelings—anything that bears on its face the marks of falsehood or extravagance. Within these limits, a "counterfeit presentment" is as good as the original. All that the most fastidious

reader can ask in an author is a certain similitude to nature. He never looks for anything more than what is called *vraisemblance* or plausibility. What *seems* to be true satisfies him as well as what *is* true.

How opposite to this the mental discipline and research required of the scientist! No illusions or half-truths can ever satisfy *his* mind. Engaged in prolonged labors to find out the laws of natural phenomena, he counts nothing as gained so long as these remain undiscovered. One after another chimeras vanish from his mind; theories are tried, only to be discarded, if found not to fit in with facts; verifications from many opposite quarters are applied to test the value of a given hypothesis; and, if, after all, any of them are seen to be at variance with it, the hypothesis is abandoned, though it may have been cherished with all the ardor of a first and only affection.

That the semblance of truth answers the purpose of almost every kind of literature, as well as the reality, and thus places it in marked contrast with the rigid requirements of science, is further manifest from this, that we often see two propositions or apothegms, entirely repugnant to each other, equally applauded by the multitude, and maintaining a place and a good character in current literature; while of two rival theories or doctrines in science, either both are sooner or later rejected, or they become reconciled, or one is finally substantiated. Every one's reading, if at all extensive, will readily suggest illustrations of the truth of this remark. A few of these inconsistencies or contradictions in literature may not be out of place here. First, we will compare what is said by two distinguished philosophers upon the subject of anger. "To be moved by passion," says Marcus Aurelius, "is not manly, but mildness and gentleness, as they are more agreeable to human nature; so, also, are they more manly; and he who professes these qualities possesses strength, nerve, and courage —and not the man who is subject to fits of passion and discontent. For in the same degree in which a man's mind is nearer to freedom from all passion, in the same degree also is it nearer to strength. And as the sense of pain is a characteristic of weakness, so also is anger. For he who yields to pain and he who yields to anger are both wounded, and both submit." On the other hand, Bacon: "To seek to extinguish anger utterly is but a bravery of the Stoics. We have better oracles. . . . In refraining from anger, it is the best remedy to win time, and to make a man's self believe that the opportunity of his revenge is not yet come; but that he foresees a time for it, and so to still himself, in the mean time, and reserve it." Next, hear what two others of the same guild have to advise us concerning knowledge: "It is a vanity to waste our days in the blind pursuit of knowledge; it is but attending a little longer, and we shall enjoy that by instinct and infusion which we endeavor at here by labor and inquisition. It is better to sit down in a modest ignorance, and rest contented with

the natural blessings of our own reason, than buy the uncertain knowledge of this life with sweat and vexation, which death gives every fool gratis" (Sir Thomas Browne). "No way has been found for making heroism easy even for the scholar. Labor, iron labor, is for him. . . . There is so much to be done that we ought to begin quickly to bestir ourselves. This day-labor of ours, we confess, has hitherto a certain emblematic air, like the annual plowing and sowing of the Emperor of China. Let us make it an honest sweat" (Emerson). Who shall decide when doctors disagree? Once more, look at what Herbert Spencer calls the "great-man theory" in history. He and Macaulay and Buckle, on one side, are as wide apart as the poles of the earth from Carlyle and Emerson, on the other, concerning this theory. Hear Carlyle first: "We can not look, however imperfectly, upon a great man without gaining something by him. He is the living light-fountain, which it is good and pleasant to be near—the light which enlightens, which has enlightened, the darkness of the world; and this not as a kindled lamp only, but rather as a natural luminary, shining by the gift of Heaven." To the same effect, Emerson: "Literary history, and all history, is a record of the power of minorities, and of minorities of one. . . . The importance of the one person who has truth over nations who have it not is because power obeys reality and not appearance, according to quality and not quantity. How much more are men than nations! . . . So that, wherever a true man appears, everything usually reckoned great dwarfs itself. He is the only great event; and it is easy to lift him into a mythological person."

On the other side, hear Macaulay: "Those who have read history with discrimination know the fallacy of those panegyrics and invectives which represent individuals as effecting great moral and intellectual revolutions, subverting established systems, and impressing a new character on the age. The difference between one man and another is by no means so great as the superstitious crowd supposes. . . . The sun illuminates the hills while it is still below the horizon; and truth is discovered by the highest minds a little before it becomes manifest to the multitude. This is the extent of their superiority. They are the first to catch and reflect a light which, without their assistance, must, in a short time, be visible to those who lie far beneath them." And here is what Herbert Spencer offers on the same side: "The origin of the great man is natural; and, immediately he is thus recognized, he must be classed with all other phenomena in the society that gave him birth as a product of its antecedents. Along with the whole generation of which he forms a minute part, along with its institutions, language, knowledge, manners, and its multitudinous arts and appliances, he is a resultant of an enormous aggregate of causes that have been operating for ages. . . . If it be a fact that the great man may modify his nation in its structure and actions, it is also a fact that there must have been those antecedent modifications constituting

national progress before he could be evolved. Before he can make his society, his society must make him; so that all those changes, of which he is the proximate imitator, have their chief causes in the generations which gave him birth. If there is to be anything like a real explanation of these changes, it must be sought in that aggregate of conditions out of which both he and they have arisen."

And so on through the literature of all nations, from the earliest times down to the present day, it abounds in antagonism of sentiment. And when two or more authors happen to agree, others will be found who will refute their positions, and convict them of mistakes; so as almost to justify that saying of Voltaire, that "the history of human opinion is scarcely anything more than the history of human error." More than this: not only will these various disagreements be discovered among different authors, but different passages in the same author will show a similar want of harmony, and, what is a greater wonder and anomaly still, the same passage, which will not want for admirers on account of its beauty and the justice and accuracy of the sentiments it expresses, will sometimes find just as many, even though its meaning be entirely reversed. Take the commencement of one of Emerson's latest essays, called "Resources," to illustrate what I mean. I place side by side with the original affirmative propositions their negatives:

"Men are made up of potences. We are magnets in an iron globe. We have keys to all doors. We are all inventors, each sailing out on a voyage of discovery, guided each by a private chart, of which there is no duplicate," etc.

Men are made up of impotences. We are magnets in a wooden globe. We have keys to no doors. Scarcely any are inventors, sailing out on a voyage of discovery. Scarcely any are guided by a private chart, of which there is no duplicate, etc.

Or take this passage from one of Dr. Johnson's essays: "It seems to be the fate of man to seek all his consolations in futurity. The time present is seldom able to fill desire or imagination with immediate enjoyment, and we are forced to supply its deficiencies by recollection or anticipation. . . . Thus every period of life is obliged to borrow its happiness from time to come. In youth we have nothing past to entertain us, and in age we derive little from retrospect but hopeless sorrow." If there are persons to be found who will subscribe to these views, there are more who will adopt the contrary, as thus: It seems to be the fate of man to seek all his consolations in the present. The future is seldom able to fill desire or imagination with sufficient enjoyment, and hence we are forced to supply its deficiencies with that which is immediate. . . . Thus every period of life is obliged to borrow its happiness from the present moment, etc.

Now, as I have before hinted, there is no chance for such contradictions in science; or, if they ever occur, their existence, from the very nature of the pursuit, can not be of permanent duration. There is no such thing as imaginary laws controlling phenomena. Nature

abhors a fallacy or a fiction more than a vacuum; and though for a stated period the true cause of a given phenomenon may be hidden from view, owing to the imperfect means or the imperfect intelligence employed to unravel it, and thus a fictitious origin be assigned for it, yet in course of time the error is sure to be detected and the truth to be revealed. Thus it was with the astronomical system of Ptolemy. Up to the time of Copernicus the learned world as well as the illiterate were led to believe that the sun and all the rest of the heavenly bodies revolved around the earth, as the center of the entire system. Yet, as soon as the error was exploded, and the truth demonstrated, there was a universal rejection of the one and a universal recognition of the other. So, at a later period, when the true theory of ethereal undulations, as applied to light, fought its way against much opposition into popular belief, the old theory of emanations was dropped, never to be again taken up.

Nevertheless, from what has been said, it must not be inferred that what are called coincidences of thought never occur among scientists. On the contrary, these are so common as to give license for believing in the existence of a law, akin to that of evolution if not a part of it, by virtue of which, in the progress of knowledge, certain new truths dawn upon the world, receiving expression simultaneously from more than one mind. Given the age which is ripe for any discovery, and it breaks out in many different quarters of the globe at the same moment. Men seem to be watching for it, and, like a meteor glancing across the heavens, it is witnessed by several observers from many points of the compass. Take, for example, the great law of natural selection, as applicable to man's origin—it was discovered simultaneously in England by Darwin and Wallace; while in Germany, at the same time, Haeckel had promulgated a similar theory; and in France, in a preceding age, Lamarck had laid the foundation for it in the most unmistakable manner.

But it is only in this single point of occasional coincidence or identity that the leading thoughts of science take on a certain likeness with those of literature. The analogy ends with the admission that each of these thoughts may have rival paternities. Beyond this the difference becomes manifest; and it consists in this: While the utterances of different literatures may seem to be original, this is often owing to a variation in their phraseology, an examination of which will show them to be identical; and, in addition to this, there is no criterion by which their truth can be tested. But in science, while different claims may be made for originality of discovery, each truth stands out in bold relief, is distinct and well defined, and, after it has been submitted to all the various verifications of which it is susceptible, it no longer admits of any doubt and becomes a part of the common stock of human knowledge, possessing, as nearly as possible, the attributes of positive, absolute, and immutable truth.

Owing to the endless tautologies of literature, it requires little discernment to see that it must be approaching a crisis in, if not a completion of, its destiny. Traveling in the same old circle, and treating us perpetually to the same round of entertainment without change or variety, it must gradually cease to interest, and eventually die a natural death. With no new oil to fill its lamps, steeped in a kind of Stygian darkness of its own creation, one may well exclaim with Othello:

> I know not where is that Promethean heat
> That can its light relume.

And that this would have been a natural result if modern science had not come to the rescue at the right moment, and furnished its proper share of this "Promethean heat," admits of scarcely a doubt, especially in view of the fact that the most successful cultivators of letters in modern times are found resorting, for their choicest inspiration, to the new fountains thus opened to use. Notably among poets such men as Tennyson, among historians such men as Buckle, and among critics such men as Taine, have availed themselves of these helps to their genius; while by differentiating the condition of man, in some of the most important particulars, science has so wrought upon his character and destiny as to render it possible for such splendid intellects as Goethe, Dickens, and Victor Hugo to say something original of him. For, if you strip their pages of what may be called their scientific coloring, if you take away what directly or indirectly may be traced to the magic web which science has woven all through the affairs of modern life, you strip them of much of their witchery and of most of their originality.

Now, without going into particulars, we may say generally that the way in which science has wrought this great reform and revolution in literature has been by widening our survey of both man and nature. From a being of comparative insignificance, ruled by the rod of a tyrant, or made the sport of demons, and whose views of things were bounded by the narrowest horizon, she has transformed man into a being of the highest order of which we have any knowledge, having risen to it by the operation of laws that have been shaping his destiny for ages. Step by step his powers have been unfolding and the range of his vision enlarging, until he has been able to find some clew to his origin, and some interpretation of natural laws that before were a mystery to him. By the aid of what may be considered a sort of "second sight," namely, instruments of his own invention, he has been enabled to explore the remotest bounds of creation, and thus literally open to himself a new heaven and a new earth. With the telescope he has reached the most distant of planets, with the spectroscope he has discovered many of their constituent elements, and with the microscope he has penetrated into the secrets of the minutest forms of insect life. Through molecular physics and the grand modern tri-

umph of evolution, both in its relation to man and the totality of nature, he has brought near to him many of the outlying provinces of human knowledge, and poured upon them a flood of light.

To the investigation of principles has succeeded the application of useful inventions. Theories have almost invariably germinated into practical science. From the study of mathematics, physics, chemistry, and geology, industries have been developed which have made the commonest dwelling of modern times a palace and the poorest cities a miracle of magnificence, compared with those of the past.

And all of this material advancement has been attended by a corresponding diffusion of knowledge and awakening of intellectual activity, so that the merest tyro in knowledge, at the present day, surpasses in intellectual acquisitions all that the most successful scholar of Greece and Rome could boast of, even though he had mastered all the learning of antiquity. More marvelous still, the latest expression of psychological science forces upon us the conviction that the mental faculties themselves, in harmony with the results of evolution everywhere else, are brought within its grasp, that they are thus enlarged in their capacity, and made equal to the task of furnishing through the revolving ages disclosures of the almost limitless secrets of the material world, and of the agency which brought it into being.

Here then, finally, we may look for the only avenue of escape from the doom with which literature was threatened—a doom not unlike that which settled over the Empire of Dullness as painted by the poet. In that picture the whole assembled concourse of wits and critics are represented as falling into a profound slumber, while listening to the sleepy literary performances of one or two of their heroes. Nor did *they* ever rise out of this lethargy. Fortunately, the comparison ends here. For while, without doubt, the same leaden slumber was fast settling over the prostrate form of modern Literature, the mighty enchantress, modern Science, touched it at the propitious moment with her potent rod, and woke into new life its exhausted and dying energies.

OBSERVATIONS ON THE CHAMELEON.

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HAVING recently come in possession of a family of these interesting little animals, I have found both pleasure and instruction in studying their habits. Others of the lizard tribe are not averse to, and many seem to prefer, the vicinity of men, while the chameleon always seeks the deep jungle, away from observation.

A woman from the jungle who happened to discover their haunts

has brought me at different times eight, one large and seven smaller ones, apparently of the same family. A large bird-cage keeps them securely, but they are turned out upon the grass, or placed on trees in the garden, for an hour or two daily, while a boy is employed to watch them, catch grasshoppers, and feed them. In the cool of the morning and evening they are not inclined to wander; but when the sun is hot. if they find that they are not watched, they are pretty sure to make for the largest trees, and then there must be a general turn-out of spare hands to look them up and capture them. As their quickest pace is only about five feet per minute, they are never able to get far away, unless too long neglected. There is great difficulty in finding them sometimes, even though we may know pretty nearly where they are, such is their adroitness in concealing themselves.

We have a small gardinia-tree, the top not three feet in diameter, and the foliage not dense enough to conceal one of them, and yet, after half a dozen of them had been placed upon the branches, I have looked for two or three seconds without being able to distinguish one, though on looking more intently I could see the whole without difficulty. So, to enable us to see them when they wander, we tie a bit of scarlet Berlin wool around their loins, which enables us to trace them easily. Sometimes when on the trees the scarlet wool may be seen bright in the sunshine when the little animals themselves are quite invisible.

The chameleon has been an object of curiosity the world over on account of its power to change its color, but its power to change its form is not less remarkable. Sometimes it assumes the form of a disconsolate mouse sitting mum in a corner; again, with back curved and tail erect, it resembles a crouching lion, which no doubt gave origin to its name, *chamai-leon*, or ground-lion. By inflating its sides it flattens its belly, and viewed from below takes the form of an ovate leaf. The tail is the petiole, while a white serrated line, which runs from nose to tip of tail over the belly, becomes the midrib. Still again throwing out the air, it draws in its sides, and at the same time expands itself upward and downward till it becomes as thin as a knife, and then viewed from the side it has the form of an ovate leaf without a midrib but with the serrate line of the belly and the serrated back becoming the serrated edges of a leaf. When thus expanded it also has the power to sway itself over so as to present an edge to an observer, thus greatly adding to its means of concealment.

I have studied the changes of color with much interest. In its normal state of rest it is of a light pea-green, at times blending with yellow. The least excitement, as in handling, causes a change. The groundwork remains the same, but transverse stripes appear running across the back and nearly encircling the body in a full-grown animal, numbering about thirty, and extending from head to tip of tail. These stripes occupy about the same amount of space as the groundwork, and are most susceptible to change of color. At first they become

deeply green, and if the excitement continues gradually change to black. When placed upon a tree the groundwork becomes a deep green and the stripes a deeper green or black, and so long as they remain on the trees the color does not change. The prevailing idea, that they take on the peculiar hue of the foliage among which they happen to be, is, I think, erroneous. We have placed them on the scarlet leaves of the dracæna and among the red flowers of the acacia, with no change from the prevailing green.

My largest specimen measures from nose to tip of tail fourteen inches, the body and tail being about equal—the circumference of the largest part of the body about six inches. The legs are thick and muscular. The form of the feet, so far as I am aware, has no parallel in the animal kingdom. They resemble two hands placed palm to palm and divided to the wrist. The outer palm has three minute fingers armed with sharp, curved claws, while the inner has but two. Opened to its full extent it clasps a space of about two inches. Hands and feet are much the same, except that the feet are somewhat larger and thicker. The entire body is covered with armor. This consists of oval plates placed edge to edge. There are about nine hundred to the square inch, giving on my largest specimen, by estimate, thirty-two thousand plates. The color has its seat in the armor.

The tail coils up into a ring quite close to the body, when not required for use. The feet and tail have great power of prehension. The animal will clasp a branch with either so firmly that considerable force is necessary to detach it. Giving the tail a turn round a twig they will throw the body forward and grasp another branch a foot or more away, and so move from branch to branch. At night they hang themselves up, sometimes by the tail only, or by the tail and one or more of their claws, and so sleep.

The eyes are cones about one fourth of an inch in diameter, one half projecting beyond the socket, completely covered with armor except at the point where the pupil is seen. This is about the size of the head of a large pin, set in a delicate ring of burnished gold. The eyes act independently of each other, the cones rolling freely in all directions, one often looking straight forward while the other is turned backward, giving them a most comical appearance.

The mouth is literally an open sepulchre. When opened you see a deep cavern almost down to the stomach, with no indications of a tongue. At the ramus of the lower jaw a deposit of whitish, gelatinous matter may be seen, covered with a thick, viscid mucus. On pressing upward beneath the jaws, a round, fleshy tongue is thrown up, a fourth of an inch in diameter and extending deep into the throat, the point of which is covered by the gelatinous deposit before mentioned, much like the swab on the rammer of a cannon. There are no teeth, but the edges of the jaws are serrated to serve the purpose of seizing and holding its game.

The lot of the chameleon is to live on trees and subsist on insects. Its motions are sluggish. It lies close upon a branch, assuming a form and color suitable to concealment, with its mouth wide open. Its viscid mucus serves to attract insects, and the moment they come in contact with it they are securely caught. When within two or three inches, the tongue is thrust out like a flash, the intruder is caught on the swab and drawn into the mouth. The tongue is then drawn down the throat, carrying the victim alive into the stomach. Beyond this we are not able to trace the process. We have seen grasshoppers to the number of half a dozen thus drawn in one after another.

Whether the change of color and form is voluntary or not, I have been unable to determine. From careful observation I am inclined to the opinion that it may be both voluntary and involuntary. Change of form seems to be quite under control, and change of color appears to be so at times.

Their intelligence seems to be of a very low order. After being separated they greet one another with open mouth and a hiss. They manifest no emotion, and no form of petting seems to be appreciated. Their instinct is to conceal themselves from observation, to climb to the highest available point, and to lie with open mouth waiting for their prey to come to them. The only activity they manifest is in the use of the tongue, and in this they are not excelled by any other animal.

In conclusion, we may notice some prominent marks of design and adaptation:

1. The power to change color and form affords the means of concealment.

2. The sharp claws and muscular power of feet and tail fit it for its abode on the branches of trees, often swayed and dashed about by the fierce tempest.

3. The tenacious mucus of its mouth attracts insects, while the darting tongue by the rapidity of its motion is an offset to the sluggishness of the creature's movements.

4. Its armor-plates afford a protection from other marauders, and also from the heat of the sun and the inclemencies of the weather.

5. It is the friend of man, subsisting mainly if not entirely on insects that are injurious to vegetation.

THE UNITED STATES LIFE-SAVING SERVICE.

EXTRACT FROM AN ARTICLE IN APPLETONS' "ANNUAL CYCLOPÆDIA" FOR 1878.

By W. D. O'CONNOR,

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THE scheme of this service places the long chain of complete life-saving stations on the Atlantic beaches within an average distance of five miles of each other, the object being to maintain the intercommunication of patrol, and effect the speedy assembling of several crews in case of the occurrence of a wreck requiring multiplied efforts. The complete life-saving stations are generally situated just behind the beach, among the low sand-hills common to such localities. They are typically two-story houses, mainly built of tongued and grooved pine, with gable roofs, covered with cypress or cedar shingles, and strong shutters to the windows, and are securely bolted to a foundation of cedar or locust posts, sunk in trenches four feet deep. Their architecture is of the pointed order, somewhat in the chalet style, with heavy projecting eaves and a small open observatory or lookout desk, on the peak of the roof, from which spires a flag-staff. The walls of the houses are painted drab, with darker color for the door and window trimmings, and the roofs dark red. Over the door is a tablet with the inscription "U. S. LIFE-SAVING STATION." The appearance of the houses is tasty and picturesque. Their dimensions are from eighteen to twenty feet wide by forty feet long; the later houses are twenty by forty-five. Below they contain two rooms. One of these is the boat-room, about ten feet high, occupying over two thirds of the ground-floor space, or measuring about sixteen by thirty feet, and opening by a broad double-leaf door into the weather. In this are stored the boats, life-car, wreck-gun, and most of the apparatus. The other room, about eight feet high, and measuring about twelve by sixteen feet, is the general living-room of the crew. The second story contains three rooms, one for the storage of the lighter apparatus, one for the sleeping-room of the keeper, and one for that of the men; both of these furnished with cot-beds in sufficient number for the accommodation also of the occasional guests sent to the stations by shipwreck. At stations where

FIG. 1.—LIFE-SAVING STATION.

there is communication with the Signal Service, there is an additional room in the upper story for the accommodation of the signal officer. The later and better built stations have interior walls of lath and plaster, and are furnished outside with cisterns for the collection of rain-water. The lack of fresh water on the beaches is one of the hardships of station-life.

The life-boat stations are usually twenty-four feet high from base to peak, forty-two feet long by twenty-two feet wide, exterior measurements, and contain a loft above, and a room below twelve feet high, twenty feet wide, and forty feet long, for the accommodation of the life-boat and its gear. They are built of matched and grooved pine, with gable roofs shingled with cedar, and are painted like the other stations. They are placed on piles at the water's edge, or set on the inner side of the piers, and are furnished with an incline platform, or trap in the floor, along which the life-boat is let down and launched into the water by a windlass. Over the door of each is a tablet inscribed "U. S. LIFE-BOAT STATION."

The houses of refuge are two-story structures, of a style common at the South, with broad gabled roofs, an ample veranda eight feet wide on three sides of the structure, and large chimneys in the rear, built outside of the wall. The houses are of pine, raised about six feet from the ground on light wood posts, and the roofs shingled with cypress. Instead of glass, the windows are fitted with wire-gauze mosquito netting. The houses are about thirty-seven feet long by fifteen feet wide, not including the veranda space. The upper story is a loft, the lower has three apartments. Each house has capacity for succoring twenty-five persons, with provisions to feed that number for ten days. A boat-house is provided for each station, furnished with a galvanized iron boat with sculls.

A complete life-saving station, fully equipped, costs about $5,000; a life-boat station about $4,500; and a house of refuge about $3,000.

The stations are fully equipped with all minor appurtenances apposite to their purpose, such as anchors, grapnels, axes, shovels, boat-hooks, and wreckers' materials and implements generally; and those which are inhabited are also furnished with stoves, cot-beds, mattresses, blankets, and the utensils requisite for rude housekeeping. The crews find their own provisions. The stations are also provided with all the most approved appliances for saving life from wrecks. First among these is the six-oared surf-boat, the light weight and draught of which make it the only boat yet found suitable for service for the flat beaches and shoaling water of the Atlantic and Gulf coast. Though not invariably of the same model, it is usually of cedar, with white-oak frames, without keel, varying in dimensions, but generally from twenty-five to twenty-seven feet long, from five and one half to six feet wide, and from two feet three inches to two feet six inches in least depth. It has commonly air-cases at the ends and along the in-

terior sides under the thwarts, which make it insubmergible, and is fitted with cork fenders running along the outer sides to protect it against collision with hulls or wreckage. Its weight is from 700 to 1,000 pounds. It is guided by a long steering oar, the steersman standing in the stern. In the hands of the skilled surfmen of our coasts, it is capable of marvelous action, and few sights are more impressive than the passage out through the flashing breakers of the frail red boat, lightly swimming on the vast intumescence of the surge, held in suspension before the roaring and tumultuous comber, or darting forward as the wall of water breaks and crumbles, obedient to the oars of the impassive crew. Though sometimes thrown back and broken in desperate and unavailing efforts at a launch against a resist-

FIG. 2.—SURF-BOAT UPON ITS CARRIAGE.

less sea, this boat, which might be upset easily, has rarely in the history of the service been capsized in passing through the surf, so great is the skill of her gallant oarsmen; and certain great surfmen, like Captain Hildreth, of Station 39, New Jersey, say that in it they will face any sea in which a life-boat can live.

On the Lakes and the Pacific coast, where steep shores or piers command deep water, and by mechanical contrivances heavy boats can be launched directly into it, the English life-boat is in general use. This wonderful contrivance, the result of a century of repeated effort, is of massive strength and stability. It is built of double diagonals of mahogany. The size generally in use in this country is about twenty-seven feet in length, a little over seven feet broad, three feet eight inches deep, carrying eight oars, double-banked, and weighing when empty 4,000 pounds. It is self-righting and self-bailing. In other words, when thrown over, which is difficult to be done, by a heavy sea, it instantly rights and empties. The first of these two extraordinary characteristics, to which a great number of advantages are sacrificed, is effected by a ponderous false keel of iron, which gives the lower part of the boat a constant determination toward the water, while an equal

determination from the water is maintained for the upper portion of the boat by a distribution of air-cases at the sides and ends, scientifically proportioned. The self-bailing characteristic is effected by a deck adjusted with reference to the draught of the boat, so that, whatever be the load of the latter, the deck is above the load-line; and, be-

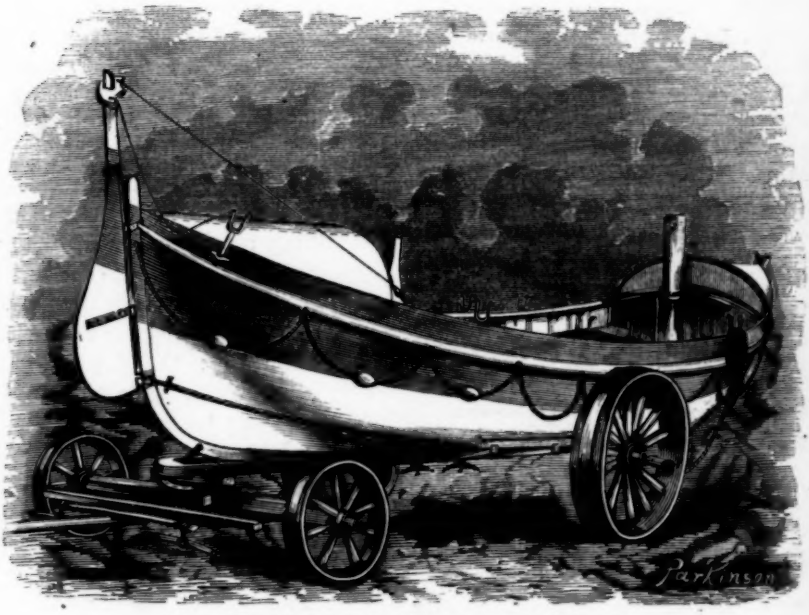
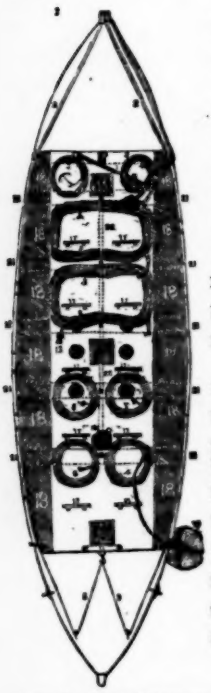


FIG. 3.—SELF-RIGHTING LIFE-BOAT UPON ITS CARRIAGE.

ing fitted with tubes extending vertically down through the bottom of the boat, it follows that whatever water the boat takes on board falls through the tubes, in obedience to the law which compels fluids to seek their level, and leaves the deck free. The delivery tubes are furnished with self-acting valves, opening to the downward pressure of the water shipped by the boat, and shutting to the pressure of the jets from below. Cork ballast adds by its weight to the stability of the boat, and augments its buoyancy in case the boat be stove. Two masts, made detachable, are provided, fitted with two low lug-sails and a jib. The boat is wellnigh invulnerable, but its great weight and draught, and the resistance its high bows offer to the wind, often make its towage by steam-tug necessary to enable it to reach a wreck at a distance. Particular attention is given to the stowage of its ropes, lines, anchors, and other articles carried in life-boats, these being arranged by a strict method with reference to economy of space and facility of use, and always kept on board, ready for service, lest any of them should be forgotten in the excitement of a sudden sum-

mons for wreck duty. Carriages of a peculiar construction are provided in England for the transportation and launching of these boats, together with skids and rollers for returning them to their carriages; but at present in this country they are let down by the trap or inclined platform directly into the water, the station being always at the water's edge. The surf-boats are provided with carriages, by which they are hauled from the stations abreast of wrecks. They are four-wheeled, with bed-pieces between each pair of wheels, on which the boat rests, and a long bar or reach connecting the front and back wheels, made separable half-way to enable the boat to be lowered to the ground by withdrawing a portion of the carriage. The American life-boat, invented by Captain J. M. Richardson, Superintendent of the First Life-saving District, five specimens of which are now in use, would seem to be better adapted for the service on our coast than the English, being considerably lighter and of less draught, and equally self-righting and self-bailing.



1. Anchor.
2. Cable.
3. Bow heaving-line or grapnel-rope and grapnel.
4. Drogue-rope.
5. Stern heaving-line.
6. 7. Veering-lines.
8. Jib outhaul or tack.
9. Mizzen-sheets.
10. Drogue.
11. Life-buoy.
12. Loaded cane, heaving-line, and tub.
13. Tailed block.
14. Pump-well hatch.
15. 16. Deck-ventilating hatches.
17. Foot-boards for rowers.
18. Side air-cases.
19. Relieving tubes and valves.
20. Samson's post.
21. Thwarts.
22. Central batten, to which the masts and boat-hooks are lashed.

FIG. 4.—DECK-PLAN OF SELF-RIGHTING LIFE-BOAT, SHOWING MANNER OF STOWING GEAR.

When boat service at a wreck is impracticable, resort is had to life-saving ordnance. The gun first in use was an *éprouvette* mortar, of cast iron, weighing 288 pounds, throwing a twenty-four-pound spherical ball with a line attached thereto, its extreme range being 421 yards. This gave place to the Parrott gun, of cast iron, with a steel tube or lining, weighing, with its ash-wood carriage, 266 pounds, car-

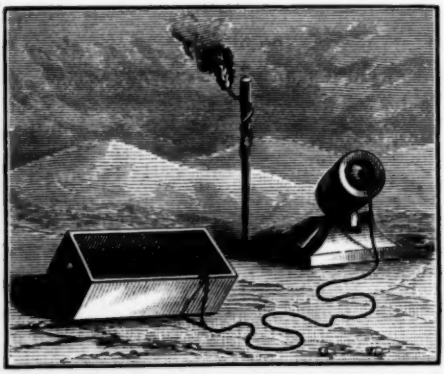


FIG. 5—ÉPROUVETTE MORTAR, FAKING-BOX, AND MATCH-STAVE.

rying a twenty-four-pound elongated projectile, with a maximum range of 473 yards. The Lyle gun, which has superseded these, is of bronze, smooth bore, weighing 185 pounds, with a cylindrical line-carrying shot weighing seventeen pounds, and a range of 695 yards. The reduction in weight over the lightest previous ordnance is 110 pounds, and the increase in range over the old *éprouvette* is 274 yards. Other advantages of the Lyle gun are its strength, owing to the tenacity and ductility of its material, its freedom from corrosion, and its exemption from the erosive action of gases, there being little windage, and from wear by the projectile, this being nearly the length of the bore. The projectile has a shank protruding four inches from the muzzle of the gun, to an eye in which the line is tied—a device which prevents the line from being burned off by the ignited gases in firing. The shot-line is made of unbleached linen thread, very closely and smoothly braided, is waterproofed, and has great elasticity, which tends to insure it against breaking. The lines in use are of varying thicknesses, according to circumstances, ranging from one eighth to three eighths of an inch, and their length varies from 500 to 700 yards. The shot-line is carried in a faking-box—a wooden chest with handles for convenience in carrying. There are two or three sizes in use, the dimensions of the largest being about three feet long by one and a half wide, and a foot deep. Connected with it is a frame, a little larger than the box, with a row of wooden pins set vertically into its four sides. A false bottom, which is a tablet of wood pierced with holes corresponding to the pins, is let down over them until it reaches their bases, and rests upon the frame. In disposing the shot-line, the faker begins at the corner, and coils it in successive diagonal loops or fakes over the pins, layer above layer, until the line is completely rove. The box is then let down over the pins, and fastened at each end to the frame. It is now ready for transportation to the scene of a wreck. When brought there, it is turned upside down, disclosing the false bottom, with the frame superimposed upon it. Two men, one at each end of the box, release the fastenings, and, each pressing his foot upon

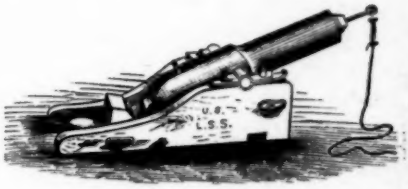


FIG. 6.—LYLE GUN.

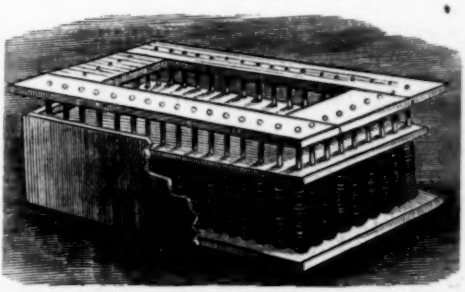


FIG. 7.—METHOD OF WITHDRAWING FRAME AND PINS FROM SHOT-LINE IN FAKING-BOX.

the false bottom to keep it down, the two lift off the frame, bringing away the pins with it. The false bottom is then lifted off the line, which remains in the box, disposed in the layers of diagonal loops or fakes made by the pins. The line is thus arranged to pay out freely, and fly to a wreck without entanglement or friction. The end is now tied into the eye of the shank of the shot in the gun; the box, which is always placed a few feet to the windward of the gun, is canted up on one side at an angle of about forty-five degrees; and the line is ready for firing. The line is always brought ready faked to the scene of action and fired from the box. In case a second shot is necessary, the line is laid out in large loops upon a tarpaulin spread out upon the beach, which is called French faking. This is done to save time,

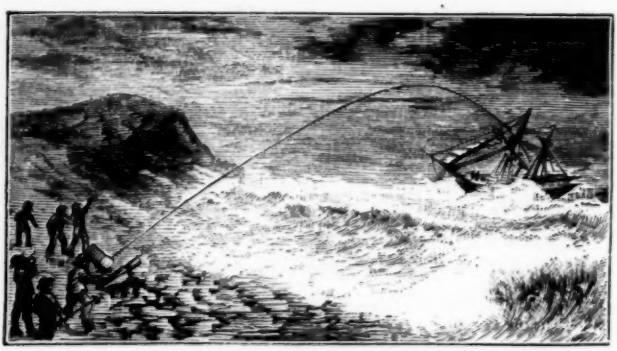


FIG. 8.—FIRING SHOT-LINE TO WRECK.

twenty-five or thirty minutes being requisite to fake a line properly in the box; but it is less desirable, as exposure to the flying sand or the rain or spray lessens the range by impeding the flight of the line. When the shot-line reaches the wreck, the shore end is connected with the whip or hauling line. This is an endless rope or ellipse, an inch and a half in circumference, and long enough to reach from the shore to the vessel. It is reeved through a pulley-block, having attached to it to several feet of rope called a tail. The shot-line is tied around both parts of the whip, a few feet above the pulley-block, and the crew of the vessel at a signal haul the whip on board by means of the shot-line. With it goes a tablet called a tally-board, on which are printed, in French upon one side and in English upon the other, directions for properly setting up the whip-line on the vessel. When this is done, a signal is made to the shore, and a hawser of sufficient length and four inches in circumference, to which is attached another tally-board, bearing printed directions in English and French for its disposition, is tied to one part of the whip or hauling line, and is sent out to the vessel by the life-saving crew pulling upon the other part. Obeying the directions of this tally-board, the men on the ship fasten the hawser to the mast about eighteen inches above the hauling-line. A crotch,

made of two pieces of wood, three by two inches thick and ten feet long, crossed near the top, so as to form a sort of X, and bolted together, is erected, and the shore end of the hawser is drawn over the intersection. A sand-anchor, composed of two pieces of hard wood, six feet long, eight inches wide, and two inches thick, crossed at their centers, bolted together, and furnished at the center with a stout iron ring, is laid obliquely in a trench dug behind the crotch. An iron hook, from which runs a strap of rope, having at its other end an iron ring called a bull's-eye, is now fastened into the ring of the sand-anchor. This strap connects by the bull's-eye with a double pulley-block at the end of the hawser behind the crotch, by which the hawser is drawn and kept taut. The trench is solidly filled in, and the imbedded sand-anchor, held by the lateral strain against the side of the trench, sustains the slender bridge of rope constituted by the hawser.

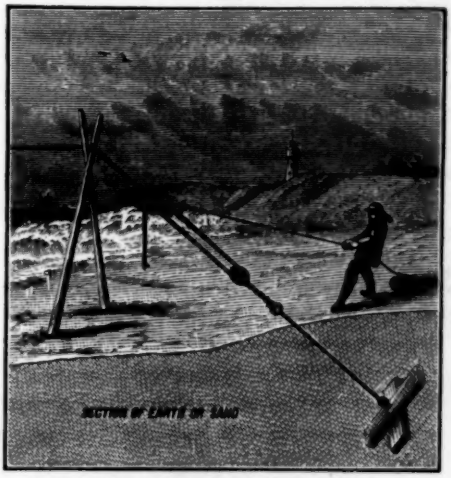


FIG. 9.—CROTCH, HAWSER, AND SAND-ANCHOR.

If there are a large number of persons to be saved, the life-car is used. This is a covered boat of galvanized sheet-iron, eleven feet four inches long, four feet eight inches wide, and three feet deep, weighing 225 pounds, which will hold six or seven persons. It is covered with a hatch, and has a few perforations made in the top from the inside, which admit air, while their raised edges exclude water. It is suspended on the hawser by bails and rings, to which are also attached the hauling-lines, all these ropes being arranged to it before the hawser is fastened behind the crotch. It is evident that, by pulling on one part of the hauling-line, the life-saving crew can send out the suspended life-car to the vessel above the surface of the sea, and, when it has received its load, draw it back to the shore by pulling on the other part. Its use has been uniformly successful, 201 persons having been saved by it from the immigrant ship Ayrshire at its first

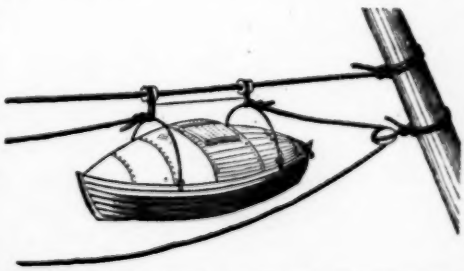


FIG. 10.—LIFE-CAR, WITH HAWSER AND HAULING-LINES.

trial, in a sea which made boat service impossible and which utterly destroyed the vessel. Another mode of using the life-car is the following: By means of the shot-line, a single hauling-line, something more than the length of the distance of the wreck from the shore, is drawn on board, the end of it being made fast to a ring at one extremity of the life-car. To a ring at the other extremity a similar hauling-line is attached, the end of which remains on shore. By the first hauling-line the car is dragged out through the water, as a boat, by those on board, and, having received its load, is dragged back again through the water by the line handled by the men on land. This method of working the life-car is resorted to under certain exigencies, but is less desirable than the other, because, although the people it contains are safe, the car is liable to be turned over and over in its passage through the breakers, much to their discomfort.

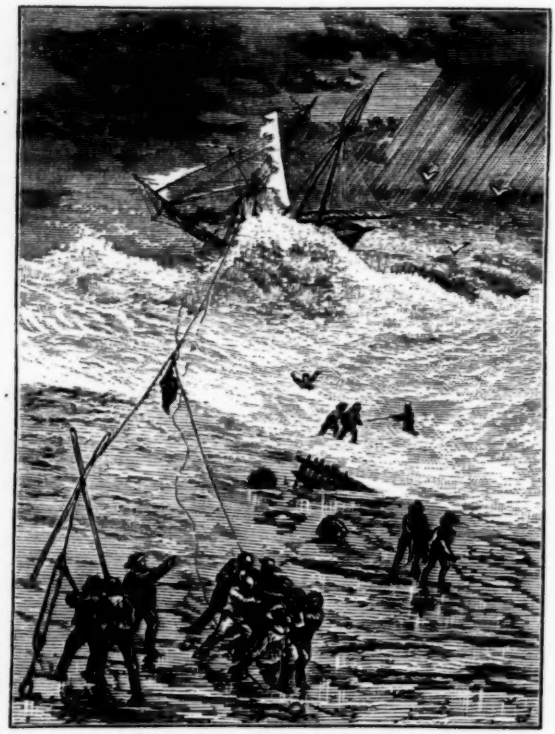


FIG. 11.—RESCUE BY BREECHES-BUOY.

The large majority of the vessels now stranded upon our coasts being coasters (schooners and barks), with crews of from six to ten men, the breeches-buoy is more commonly used. This is a much lighter contrivance, and therefore easier to transport and handle, weighing only twenty-one pounds, and requiring for its use less heavy

cordage, the difference in weight between the two with their appendages amounting to over 500 pounds. It consists of a common circular life-preserver of cork, seven and a half feet in circumference, to which short canvas breeches are attached. Four rope lanyards fastened to this circle of cork meet above in an iron ring, which is attached by a strap around a block, with composition sheaves, and is

FIG. 12.—USING THE BREECHES-BUOY WITH HAULING-LINE WITHOUT HAWSER AND TRAVELING BLOCK.

called a traveler. The hawser passes through this block, and the suspended breeches-buoy is drawn between ship and shore by hauling-lines, like the life-car. At each trip it receives but one person, who gets into it, sitting, holding to the lanyards, sustained by the canvas saddle, with his legs dangling below, and is pulled swiftly ashore. When there is imminent danger of the breaking up of the vessel, and great haste is required for the rescue, the hawser is sometimes dispensed with, one part of the hauling-line being used for the buoy to travel upon.

The apparatus having to be drawn by the men where horses are not accessible, a hand-cart is provided for this purpose, strongly built, with large wheels having five-inch tires to keep them as much as possible from sinking into the sand. The surf-boat is dragged in the same way on its carriage.

A medicine-chest is furnished for each station. It contains wine and brandy, mustard plasters, volatile salts, probangs, and a few other simple remedies and appliances for reviving exhausted persons or aiding to restore those apparently drowned, printed directions for the use of which are pasted within the lid of each chest. A method of resuscitation is published in the regulations of the service, which is also practically taught to every member of the crews by the visiting surgeon. The method is that of Dr. Benjamin Howard, of New York, with certain modifications by Dr. John M. Woodworth, late Supervising Surgeon-General of the U. S. Marine Hospital Service. Its extreme simplicity of application and great general utility merit for it a particular description. It begins with the attempt to arouse the patient, who must not be removed, unless there is danger of his freezing, but his face exposed to the fresh air, the mouth and nostrils wiped

dry, the clothing quickly ripped open so as to expose the chest and waist, and two or three quick, smarting slaps given upon the stomach and chest with the open hand. If the patient does not at once revive, a bit of wood or a cork is placed between his teeth to keep the mouth open, he is turned upon his face, a large bundle of tightly rolled clothing is placed beneath the stomach, and the operator presses heavily upon his back over the bundle for half a minute, or as long as fluid

FIG. 13.—THE FIRST STEP TAKEN, BY WHICH THE CHEST IS EMPTIED OF AIR, AND THE EJECTION OF FLUIDS IS ASSISTED.

flows freely from his mouth. (See Fig. 13.) The mouth and throat are then cleared of mucus by introducing into the throat the end of a handkerchief wrapped closely around the forefinger; the patient is turned upon his back, under which the roll of clothing is placed so as to raise the pit of the stomach above the level of any other part of the body. If an assistant is present, he holds the tip of the patient's tongue, with a piece of dry cloth, out of one corner of the mouth, which prevents the tongue from falling back and choking the entrance to the windpipe, and with his other hand grasps the patient's wrists and keeps the arms stretched back over the head, which increases the prominence of the ribs and tends to enlarge the chest. The operator then kneels astride the patient's hips and presses both hands below the pit of the stomach, with the balls of the thumb resting on each side of it and the fingers between the short ribs, so as to get a good grasp of the waist. (See Fig. 14.) He then throws his weight forward on his hands, squeezing the waist between them with a strong pressure, counts slowly one, two, three, and, with a final push, lets go, which springs him back to his first kneeling position. This operation, which converts the chest of the patient into a bellows, is continued at a rate

gradually increased from four to fifteen times in a minute, and with the regularity observable in the natural motions of breathing which are thus imitated. If natural breathing is not restored in three or four minutes, the patient is turned a second time upon the stomach in an opposite direction from that in which he was first turned, the object being to free the air-passages from any remaining water. The artificial

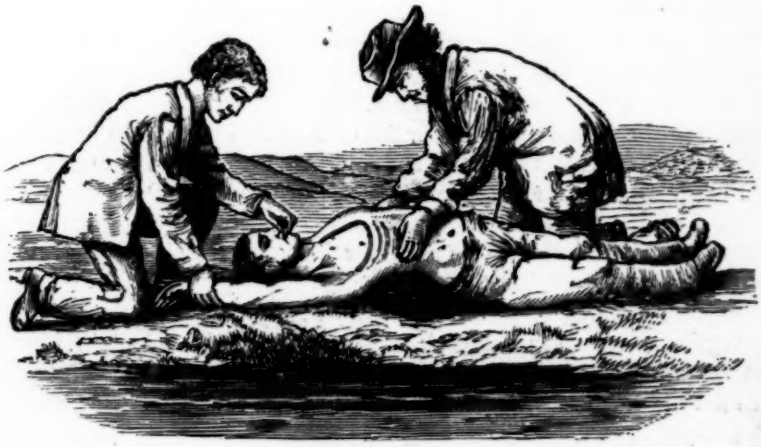


FIG. 14.—THE POSITION AND ACTION OF THE OPERATOR IN PRODUCING ARTIFICIAL RESPIRATION.

respiration is then resumed and continued if necessary from one to four hours, or until the patient breathes, and when life appears the first short gasps are carefully aided by the same method. From the first, if assistants are present, the limbs of the patient are rubbed, always in an upward direction toward the body and with firmness and energy, the bare hands being used, or dry flannels or handkerchiefs, and the friction kept up under blankets, or over dry clothing. The warmth of the body is also promoted whenever possible by the application of hot flannels to the stomach and armpits, and bottles or bladders of hot water, or heated bricks, to the limbs and the soles of the feet. As soon as breathing is established, the patient is stripped of all wet clothing, wrapped in blankets only, put to bed comfortably warm, but with a free circulation of fresh air, and left to perfect rest. For the first hour a little hot brandy-and-water, or other stimulant, is given every ten or fifteen minutes, and as often afterward as may be expedient. After reaction is established the patient is in great danger of congestion of the lungs, and unless perfect rest is maintained for at least forty-eight hours he may be seized with difficulty of breathing, and death ensue if immediate relief is not afforded. In such cases a large mustard plaster is placed upon his chest, and, if he gasps for breath before the mustard takes effect, his breathing is assisted by the careful repetition of the artificial respiration. In connection with this process the surfmen are

instructed to consider the clinching of the jaws and semi-contraction of the fingers, which have been considered signs of death, to be on the contrary evidences of vitality, and to borrow from them hope and confidence for redoubled effort in the work of resuscitation. This is a discovery of Dr. Labordette, of the Hospital of Lisieux, in France. He found by numerous experiments that the jaws and hands relax when death ensues, *rigor mortis* supervening later.

The Merriman life-saving suit is supplied to the stations, and often proves useful by enabling surfmen to effect rescues of individuals struggling in the breakers, and even to reach wrecks and assist benumbed crews to set up the life-lines. It consists of footed pantaloons of India-rubber, and above the waist of a double ply of the same material covering all but the face, and inflated severally in breast, back, and head, between the plies, by three rubber tubes. Being thus buoyant, and also impervious to air, its wearer can neither drown nor freeze. Since its original introduction at the stations, the exploits of Paul Boyton have given it celebrity.

Upon occasions of boat-service, the life-saving crews are required by regulation to wear the cork life-belts devised by Captain Ward, the Inspector of the Royal National Life-Boat Institution of Great Britain. These life-belts weigh severally only four and a half pounds;

FIG. 15.—LIFE-SAVING DRESS.

FIG. 16.—CORK LIFE-BELT.

are flexible, being composed of a series of small blocks of cork strung together; have crenellations under the arms, leaving those members unimpeded in action; and, by rendering the surfmen secure from drowning, double their efficiency to assist others in case of exigency.

The stations are opened for service on the seaboard from September 1st to May 1st, or for a shorter period wherever deemed prudent,

and on the Lakes from the opening to the close of navigation. Strict watch and ward is maintained during this period—at the life-boat stations by lookout, and at the complete life-saving stations by patrol. The period between sunset and dawn is divided into watches, each kept by two men of the crew of six at the several stations. In conformity with this routine, two men issue at sunset from each coast station. They carry beach lanterns and are provided with Coston signals, which are cylindrical cases of combustible materials, fitted into percussion holders. One man goes to the right, the other to the left, each continuing along the beach, keeping watch to seaward, until he meets a similar patrolman from the next station, when he returns to the starting-point, where he sets out again, keeping up his march until the term of his watch expires and that of the next patrol begins. Thus, every night, along the ocean beaches, in moonlight, starlight, thick darkness, driving tempest, wind, rain, snow, or hail, a file of sentinels is strung out, steadily marching, on the lookout for endangered vessels. The duty is arduous, often terrible. Storm tides flooding the beach, quicksands, the bewildering snowfall, overwhelming blasts, bitter cold, are often conditions to the journey. The result is that, should a vessel strand, which usually takes place on some shoal or bar at from one to four hundred yards' distance from the beach, instead of being left unnoticed for many hours, to be torn to pieces by the furious surf, she is sure to be soon discovered by the patrolman. Seeing her, he at once strikes the bottom of his percussion holder, driving its spike into the Coston cartridge, which ignites with a fierce deflagration, reddening the darkness, and notifying those on board the wreck that they are seen. The patrolman then races to his station and brings the crew. The keeper knows by the state of the surf whether the boat can be used, or whether to resort to the life-car, or breeches-buoy. The boat always puts out if possible, this being the speediest mode of succor. If the surf be impassable, the wreck-gun casts its lariat over the wreck, the hawser and hauling-lines are set up, and the imperiled seafarers are drawn ashore. By whatever mode the rescue is effected, it involves hours of racking labor, protracted exposure to the roughest weather, and a mental and bodily strain under the spur of exigency and the curb of discipline which greatly exhausts the life-saving crews. In the case of the boat-service, whether by surf-boat or life-boat, tremendous perils are added to new hardships. The result of these gallant toils in the rigors of the winter beach and the drench of the surf, since the date of original organization in 1871, has been extraordinary. During this period of eight years statistics show that there have been, within the scope of life-saving operations, 6,287 persons imperiled on stranded vessels. Of these, 5,981 were saved, and only 306 lost—197 of these at wrecks remote from stations, or at times when they were closed, and the others, in nearly every instance, under circumstances which rendered human aid impossible. During this period the sta-

tions have also given succor to 1,382 persons. Their crews have, moreover, notably performed wreckers' duty, and saved large amounts of marine property. The virtue of organization is attested by these results, but large credit must always be given to the noble fidelity, capability, and dauntless courage of the stout groups of seven who man the lonely stations. Wherever native manliness is held in honor, these heroic Pleiads of the seaboard beaches, and the gangs of nine who drive the life-boats through overwhelming seas upon the Lakes and the Pacific, with hearts greater than danger, can never fail of their meed.

DISEASED CONDITION OF THE FACULTY OF WONDER.

By Professor GAIRDNER,
OF THE UNIVERSITY OF EDINBURGH.*

I HAVE never gone into this matter professionally, or even as a scientific man, but have always on the other hand held that the duty of a physician toward these things was to have as little as possible to do with them. But, still, in my career instances have come to my knowledge, and it was in consideration of all these that I was led to attempt to formulate a few nights ago the state of my mind upon the subject by saying—and it is something like a distinct, and I think not an untrue and unintelligible definition—that I call the state of mind of people inclined to spiritualism *a diseased condition of the faculty of wonder.* I hold that the faculty of wonder, or reverence, if you like to call it so, is an innate and necessary part of the human mind. Nay, more, it is one of the most essential, one of the most beneficial of all our endowments—that faculty by which we grasp, by which we strive to a certain extent to comprehend, and, if we do not comprehend, submit ourselves to, and even delight in the unknown—by which we strive to apprehend that which we can not comprehend. You will easily see that the higher aspect of this faculty of wonder is the basis of the whole of our religious aspirations. Therefore it can not be that I mean to denounce it—to speak ill of it. But, like all our other faculties, this part of our mental constitution is liable to abnormal action—in fact, to get into a state of disease. What I said of this faculty is, that, when it is rightly applied by a thoroughly healthy mind to the connection between the spiritual and the material world, it does or should find abundant opportunity for its exercise within the realms of strict law. I do not mean here to touch or raise the question whether there are what are called miracles connected with

* Extract from a lecture to his class, on the subject of spiritualism.

the spiritual world any more than in the physical world. That is beside my argument. My argument at present is simply this, that within the realm of law, clearly understood as such, there is food for the faculty of wonder in all its legitimate aspirations far more enduring, far greater, and far grander than anything that can be developed in the way of those communications of table-turning, table-rapping, or anything of that kind. And the instance I gave was just one out of endless instances—to try and conceive of the manner in which the spirit of man, that which he knows to exist, and, in fact, to be himself —his *ego*—communicates through his nerves with his muscles—how it is capable of being so minutely directed that along the lines of nervous communication it will arrive at a particular muscle or particular group of muscles, and perform all the complicated muscular acts which we know to be the physical and tangible results of the manifestations of our spirit. In other words, the most commonplace appearance of a spirit that you can name—the most every-day manifestation in the world, and that which we are most certain of in our own consciousness —is, when you come to think of it, an absolute and perfect mystery, which only becomes comprehensible to us because we know it to be a fact, and because it lies within the divine order of things. It is physiological. What spiritism or spiritualism appears to require of us is, that having got our every-day consciousness of this matter for wonder —having got all this marvelous adaptation of spirit to matter—having a set of thoroughly organized and thoroughly known channels by which the spiritual world is revealed in the material, and by which the Great and Supreme Spirit is enabled to reveal himself to every one of us—having, I say, got the absolute proof and evidence in our own souls and our own bodies of a set of laws appertaining to this matter, what spiritualism requires of us to do is to cast aside the whole of these laws, and to admit a set of interferences, not exceptional, not for grand and very, very exceptional objects, but a set of every-day constant interferences with the law of the action of spirit and matter —as such, known to all of us—interferences which are not only not in accordance with that law, but which are absolutely subversive of the ordinary results of that law. Just let us suppose this: Suppose it proved, once for all, that the spirit of a departed person—a disembodied spirit, a spirit that is wandering in space, a spirit which is not limited by the conditions of material investment—has the power to appear to you, and to reveal to you what is being done or written, or has been done by some friend of yours on the other side of the globe, or who has passed beyond the grave, and that it has had access to documents no mortal could have seen, what appears to be the necessary consequence of this doctrine? This, among others, that no scrap of writing—that no single act that a man does could be concealed, or at least could be perfectly sure of being concealed, from his neighbor —from any man who may have the greatest possible interest in know-

ing it, perhaps for a nefarious purpose. You write a document of the most private character; you shut it up in a locked drawer; it affects the character of many persons; it would be treason to morality to publish that document in the newspapers. There is nothing to hinder, so far as we know the laws of this newly invented spirit world*—there is nothing to hinder any disembodied spirits who are about from getting access to the paper, and having it published in the newspapers. But here I say on the other hand—and this is the result of experience—it has been shown that this can not be done.

Having alluded to the incident of a £100 note being left in a sealed envelope in the Bank of England, the owner having promised to give it up to any spiritualist who could tell the number, but for which no application was received, Professor Gairdner proceeded: It was in some way or other impossible, apparently, for the spirits, greater or less, although it was asserted that they were able to reveal the secrets of one man's heart to another, to read the number of that note in these circumstances. I say that it was not only in fact impossible, but I say this, that, had it in fact been possible, it would have shown a state of matters which, humanly speaking, would have been subversive of the divine order. It would have entirely destroyed that system of law by which we know that, in a way which is absolutely wonderful and absolutely inscrutable, spirit does communicate with matter, as we know, every day of our lives in this world. The state of mind of the persons who come prepared to believe these things—who come to the investigation of them with previously established ideas, who regard doubt or hesitation as I would say, a sin, but let us rather say an error, and a sure way of keeping manifestations back, while open-mouthed credulity is the only frame of mind in which to come to the investigation; the state of mind of such persons—who, I believe, may be numbered in thousands, and possibly in millions, in this country and in America—is, to my idea, a diseased state of mind. I admit fully that many of these persons are apparently able to conduct their own affairs. I freely admit that many of them are very moral and well-intentioned persons. I am equally inclined to believe that this Mr. Allan Kardec, within certain limits which I can not attempt to define, was a truthful man. But that does not hinder me from believing that there is disease at the bottom of these things, and it is a disease of the faculty of wonder, by which that faculty, intended for the noblest purposes in the organization of the human mind, is perverted to some of the lowest of all purposes, and even to the abetting

* The preceding portion of the lecture shows by extracts from the works of spiritualists, and especially of Allan Kardec, that according to these authorities lying, mischievous, and impish spirits everywhere abound, and are permitted to play their pranks freely for the delusion of those who are willing to be deluded; whereby the thorough going spiritualist finds no difficulty in explaining, according to his theory, proved instances of absurdity or imposture.

of trickery. One other thing I had on my lips to say the other night, but I did not say it then, and I am not quite sure that I should do so now; therefore I can only indicate it very slightly. It is that this conclusion as to the diseased nature of these manifestations, so far as the mind of the recipient is concerned, was impressed upon me at a very early period during the epidemic of manifestations—of electro-biology as it was called then—in 1851 in Edinburgh. I had a dear friend, since dead, and dead under circumstances that no injury to him or any one else can be brought about by telling the story. He was of a bad constitution originally. He had entered on the study of medicine, and with such ardor had he taken up the branch of physiology that I regarded him as likely to be one of the greatest physiological inquirers of the day. I had not only respect for him as one of my pupils, but I had for him a feeling of regard and love. He was drawn into the vortex of Dr. Gregory's drawing-room exhibitions, and his case appears in Dr. Gregory's book; I knew it was disease; I felt it was disease. He was made to go out of himself; he was made to wander here, there, and everywhere; he was made to converse with all the philosophers of ancient Greece—with Aristotle, with Socrates, and with Plato, and to tell what they said to him. He then took a somewhat serious illness, and I became his medical attendant, and for a time he was under my care alone. The persons who had obtained this strange influence over him still kept coming about him, but at last I had to forbid their presence. He got over his illness, and became so far better, and they then again attempted to catch him, but failed. Their power had gone, or almost gone, and only the poorer class of manifestations could be produced, and ultimately none of them could be produced, and for a considerable time after that he continued in better health. But the essentially diseased character of the whole thing was plain from this, that within a year or two he showed manifestations of actual insanity. The poor fellow excited my sympathy, and I made an effort to save him. I took him to London, got him to apply himself to histology, and tried to excite all his better and scientific predilections. But the morbid tendency was too strong, and ultimately he ended his days within the walls of an asylum. I do not mean to say that Dr. Gregory made him mad. That would be wrong. I do not think that was so, because he was better for a good while after that, but I mean to say that the tendency of these things in a constitution hereditarily predisposed to insanity is to insanity, or as Shakespeare has put it in the mouth of King Lear, when conscious that he is himself upon the giddy verge, "That way madness lies."

ARE EXPLOSIONS IN COAL MINES PREVENTABLE?

By FRANCIS R. CONDER, C. E.

THE heaviest tax that can be imposed upon a nation is one that is paid in human lives. From whatever point of view the subject may be regarded, this conclusion is irresistible. If we look at it according to purely economical considerations, we may obtain very remarkable results. It has been estimated that an actual money cost of £300 is incurred in raising a boy, cradled among the poorest classes, from birth to manhood. It does not require us to ascend very high in the social scale before we find that this estimate must be trebled. If we take what we may call the cost price of the human unit at any definite time, say at £500 on arriving at maturity, the producing power of the unit in question will bear some relation to that sum; the more costly and careful education producing, as a rule, the more valuable result, as to productive power. If the laborer who earns 14*s.* or 15*s.* a week adds £50 per annum to the wealth of the country, the physician, the scientific military or naval officer, the barrister, or the engineer, may look forward to the time when his yearly labor will be worth more than a hundred times that amount, even if appraised only by the price he is actually paid for his time. Taking any producing individual, whether valued at £50 or at £5,000 per annum, at any period of his career, no income tax to which he can be subjected can approach in its pressure the extravagant tax of death. For the payment of that tax at once annihilates the total earning power of which there was, until that moment, a fair mathematical expectation.

The tax upon human life which is caused by war is one as to which philosophers and philanthropists have long written, and as to which generation after generation has complacently declared its own advance on its barbarous ancestors; although generation after generation has too often seen increasing holocausts offered on the altar of battle, with continually less and less excuse—the word justification it is too often but a mockery to use. We have seen, not so very long ago, that peace has its death tax as well as war. And we wish to call attention to a tax of this nature which, as far back as statistics have been collected, appears to be paid in this country with a grim and appalling regularity.

Regularity, that is to say, when viewed in the light of statistical returns. From any other point of view the deaths of which we speak occur with the most frightful and unexpected caprice. There may be a period of months during which none of the calamities which quietly occur are brought under public notice. Then there may be a terrific telegram, and an announcement in the largest letters used by the daily press, "Frightful calamity at a coal mine—sixty lives lost!" Again,

at another time, three or four minor calamities occur on the same day, at different spots; or within a few hours or days of one another. The public is, no doubt, deeply moved by these announcements. Free and charitable aid never fails to be forthcoming for the widowed and orphaned survivors of a colliery massacre. The question is ever newly raised, "Can nothing be done to prevent these terrible disasters?" Legislators try their hands at prevention. Men of science try their hands at prevention. It is pointed out authoritatively that much of the loss of life thus occurring is preventable loss. Robert Stephenson, when admittedly standing at the head of his profession, being himself a large colliery owner, and having for several years of his life had to descend a coal-pit at 4 A. M. daily, to visit all the workings of the mine, declared that there was hardly a colliery in England that might not be worked with perfect safety from explosions; and pointed out that the great means for insuring safety was to quadruple the shaft area in every colliery. And yet the slaughter goes on! In 1864 it was at its minimum. Only 857 lives destroyed in coal mines are reported for that year, being at the rate of a human life for every 110,000 tons of coal raised. In 1866 it attained its maximum, the lives lost amounting to 1,484, or one for every 68,000 tons of coal. From 1861 to 1875 inclusive, 15,908 lives were lost in raising 1,608,576,193 tons of coal, being very nearly a thousand deaths in each year. Roughly speaking, the life tax is at the rate of a life per 100,000 tons of coal.

The comparison of the number of men employed, of tons of coal raised, and of lives lost, year by year does not appear to throw much light on the subject. Such a comparison, indeed, shows a steady decline in the industrial and productive power of the colliers. But no relation is discernible between the out-put per man, taken as indicating either the number of hours worked on the average, or the industry exerted in these hours, and the death rate. From 1861 to 1866 occurred a steady increase in the productive power, not only of the collieries of Great Britain, but of the individual colliers. In 1861 the total yield of 86,039,211 tons of coal was produced by 282,473 men, being at the rate of 305 tons of coal per man. In 1866 the yield had risen to 315 tons per man, and in 1870 to 321 tons per man. From this year the productive power of the miners has decreased, although that of the collieries has continued to advance. In 1874 each miner only raised 249 tons of coal. In 1875, 133,306,486 tons of coal were raised by 525,843 men, being at the rate of 253 tons apiece. Thirty years previously, in 1845, the number of tons of coal raised in the year was 31,500,000. An increase to a fourfold amount, when the figures attained are so large, is probably without a parallel in productive industry. In 1840 about 700 collier vessels were employed in the London trade. Their average cargoes were 220 tons. In 1876 the fuel shipped to foreign countries amounted to 16,299,077 tons, and that sent coastwise to 11,015,178 tons.

At the time when the details of the coastwise coal trade were discussed by the Institution of Civil Engineers, in the presence of Mr. Robert Stephenson, in 1855, so little was it anticipated that railway conveyance would compete with the sea-borne traffic in coal for long distances, that the possibility was not even suggested in the debate. The Great Northern Railway was then open to Doncaster, and the coals conveyed over the line were enough to make the gross weight passed over the up lines as 1·74 to 1, the cost of maintenance being as 1·98 to 1. Mr. Carr observed that more damage was done to the permanent way, as might be supposed, by the extreme loads of the coal trains than by ordinary goods and passenger trains, and said that "this would account for the deterioration increasing more rapidly than the tonnage." Mr. Stephenson stated that the wear and tear of the way was proportionate to the number of pairs of wheels that ran over it, and to the weight on those wheels; and declared on another occasion that he could not, as a man of honor, be a party to the carrying of his own Clay Cross coals on the London and Northwestern Railway, at the freight of one halfpenny per ton per mile, as such a rate was injurious to the railway company.

To return to the casualties of the coal mines. The most terrific form of destruction, that of explosion, is not the most fatal, numerically regarded. Taking an average of fifteen years, twenty per cent. of the fatal casualties were attributable to explosions, thirty-three per cent. to falls of coal and of roof, fifteen per cent. to shaft accidents, and the rest to miscellaneous causes. Thus of the tax of ten lives per million tons of coals, the fifth part, or two lives per million tons, may be regarded as deaths that are certainly preventable by the due enforcement of those provisions which the mining engineer decides to be proper. In the years 1867–'69 the mortality from explosions amounted to twenty-nine per cent. of the whole. The general average for those years shows a death rate of one life per 84,000 tons of coal; so that we may regard the effect of the precautionary measures taken by the Legislature as having effected a saving of about a third of the number of human lives that would otherwise have fallen victims to explosions.

The question not unnaturally arises, What is the real cause that leads the miner to affront a peril of this frightful magnitude? It is all very well to speak of recklessness of life, of objection to innovation, of ignorance of scientific principles, and the like, but those who are most familiar with the working classes will be the least disposed to admit that the true knot of the question can thus be cut. It requires no instruction in chemistry for the miner to be made acquainted with the fact that the vapor (if we must not use the word gas) that he sees burning brightly as it issues from the coals in his kitchen fire is apt to issue from the face of certain coal mines, and that it will take fire in the mine as readily as in the grate. He may not be, and probably is

not, aware that this fire-damp is composed of about one third hydrogen and two thirds carbon. He may be ignorant that the proportions of admixture of fire-damp with ordinary air which are such as to cause explosion are, when the former is more than one fourth, and less than one sixteenth, of the quantity of the latter. But he knows that when he enters a fiery mine his life is in his hand. He may not know that the barometer indicates a more or less dangerous condition, as a rule, in every fiery mine. But he does know that any blow of his pick may open a "blower," or jet of fire-damp, in the mine; that if this jet meets a naked light it will take fire; and that unless the ventilation sweeping through the mine be such as to maintain a complete control over the issue of the fire-damp, which is always to a certain extent going on, the workings will be wrapped in a blast of flame, and none will be left alive to tell how it occurs. He knows, too, that the "Geordie," the invention of an old miner, whose name should be held in honor by the British workman as that of a family saint or household god, instead of setting the "fire-jack" alight, will indicate its presence by a harmless explosion within its own tube, and will then become extinguished. Or if the mine in which he works be one in which the "Davy" lamp is used, instead of the "Geordie," he knows that the little cage of wire gauze will become filled with flame if placed near a "blower" or held in the top of a working where there is too much gas to be safe, but that the flame will not pass through the meshes of the protecting shield. His is not the class of mind which can be brought to regard the safety-lamp as a talisman, giving protection to the miner who works with a naked light close by his fire-proof companion. It is more than probable that the increased safety from explosions to which we have referred may be mainly, if not altogether, due to the action of the Government inspectors in preventing the use of powder in fiery mines. Where blasting is allowed, the onus of responsibility is taken from the shoulders of the miner, and thrown on those of the superintendent. But, in the last two terrible casualties which have brought desolation to so many homes in the Black Country, there has been no question of blasting. A sudden outpour of fire-damp must, in each of these cases, have come in contact with a naked light. In cases where no miner has been left alive to tell the tale, there has often been found a mute but unimpeachable witness. A lamp has been found unlocked, a candle half burned, a box of matches half consumed. One or more of the miners, in spite of regulation, in spite of inspection, in spite of peril of his life, has had a naked light in his possession. What can have induced him to run the risk?

It is not surprising that the question should have proved utterly insoluble to those who have never been underground; nay, more, to those who have never worked underground. In the absence of that personal experience which throws a very strong ray of light on the obscurity of the question, it is easy to take a leaf out of the book of a

certain group of teachers, and throw the whole blame on the "depravity of human nature." True, it is not conducive to delicacy of feeling or to accuracy of scientific perception to toil for hours together in the Cimmerian gloom of the coal mine. Very little idea can be formed, by forty-nine fiftieths of the population of this country, of the cost of human toil at which their houses are kept warm and bright. Especially when the coal is worked in thin beds is the toil of the miner all but intolerable. In some instances he actually lies full length on the floor of the working, clad in nothing but a scanty pair of drawers, working with his pick a little in advance of his head as he lies. Nor does he cast off the badge of toil when he returns to the light of day. The other day a colonel in the army, a man deeply interested in all mechanical and scientific improvement, who was staying in one of the great mining centers, happened to go to a public establishment in the town in order to take a Turkish bath. While he was waiting for his room, two miners came out, who had been enjoying that unusual luxury. "I say, Jack," said one of them, "Moll won't know me. She never saw my skin white." His wife had never seen him washed, except his face. This may be an extreme case; as in some of the Welsh districts the "tubbing" of the men on the Saturday night takes place before the doors of their houses. But we give the incident as it actually occurred.

But pass all this. Let us attribute to the miner as extravagant a perversity of nature as the most zealous missionary can insist upon—he is at all events something better than a beast. Even a beast has the instinct of self-preservation. In man it is, there can be no denial, usually the very keenest of his instincts. And whatever the miner may know, and of whatever he may be ignorant, from his first apprenticeship underground he has had held up to his imagination the fearful and ever-present peril of the fire-damp. Abuse him as we may—and for our own part we should be very sorry to speak of him in any terms but those of cordial respect—we have not got a single step on our journey toward the solution of the question, What makes him run a risk that he knows to be hazardous?

Reader, have you ever been underground—not for amusement or out of curiosity, but in the discharge of your duty? If so, have you ever been alone underground, in a solitary point of the workings? And, if so, have you ever, by any accident, found yourself left in total darkness. The writer has had this experience, and it is one that leads him to speak with somewhat more of human sympathy for the collier than might be natural for a literary man who is not also a workman.

The oppression of utter darkness on the human organization is terrible. And hardly less than the oppression of utter darkness is the irritation produced by inadequate light. When, as they begin to number seven times seven years, the gradual diminution in the focal length of the vision often suffers a rather rapid increase, persons who

have had the disagreeable experience know that the first intimation that they must have recourse to spectacles is one of the most painful experiences of ordinary human life. At all times the want of sufficient light to see by is a hard trial. The more need there is of attentive vision, or the more the eye perceives the failing of its own power, the more intolerable is the hardship. Now, in mining the attention has to be kept vividly directed to the effect of every blow of the pick. There are many kinds of work which can be done with but little exertion of eyesight. Mining is not one of them. In a fair face of coal the operation of "getting," as it is called, may be a straightforward one; but this is far from being always the case. We have seen, too, that it is not always to the face of the coal that the chief care of the miner has to be directed. One third of the lives lost are due to falls, of face or of roof. With every blow of the miner's pick that danger has to be borne in mind. It is a danger increased tenfold by obscurity. The experience of our public works is enough to prove that, if the workings of our mines could be made as light as day, both shaft accidents and accidents from fall of roof would be enormously diminished in number. Does the reader know how the miner has to ascertain whether the roof is coming in upon him, or whether the "creep" from below is overpowering his hastily fixed props and polling boards? We can tell him from experience.

A piece of damp clay is, or should be, always at hand in a mine. Frequently it is to be met with in the workings. If not, some should always be brought down. In cases where there is no fear of explosion, and indeed in all cases fifty years ago, a bit of wet clay forms the usual miner's candlestick. In cases where luxury is studied, a bit of wood with a hole in it carries the "farthing dip." But even this fastidious candlestick, if it has to be set down on the ground, is made secure from a casual overset by a dab of wet clay. Now, if any undue cracking is heard in the timbers, or if a rattle from above gives warning that the roof is not altogether in a stable condition, what does the miner do? He smears a bit of wet clay into any crack that he observes in a prop, polling board, or junction of the timbering of the mine, and then quietly watches, to see whether the damp clay cracks. If not, it is probable that the timbering is sufficient for its work. If it does, the timbering has, in all haste, to be strengthened. Peril of life is on the one hand, anxiety to see as clearly as possible on the other. The miserable ray thrown by the miner's lamp seems only to mock his anxiety. Is there any wonder if he affronts the more distant peril in his desire to avoid the more threatening one? His nose, he may think, will give him timely warning of the neighborhood of "fire-jack." To guard against the more fatal danger of roof-fall he has only his eyes. Is there any wonder that he seeks for more light, even at the risk of a naked flame?

We do not, of course, for a moment intimate that it is only for the

sake of looking to the safety of the roof that the miner has a naked light when he ought not to have one. But we think that there is little doubt that such is often the case. And we mention this only as one of those countless occasions, known only to those who have had subterranean experience, in which the desire for more light than that afforded by the ordinary safety-lamp may become uncontrollable. Our argument is, that some strong instinct of human nature must be at work in order to lead the miner to affront the known danger of explosion from the use of naked lights so frequently as we have but too much evidence that he is in the habit of doing. And we think that there is enough to account for this in the instinctive desire for light, and more especially in the maddening effect of obscurity when accuracy of vision is required.

If we have thus rightly judged, the first effect of the remark should be to remove a very heavy load of obloquy under which our colliers as a body have hitherto labored. More than that, the more any public writer has been acquainted with the chemistry of the coal mine, the louder has usually been his condemnation of the recklessness of the miner. No doubt, from the chemist's point of view, there is but too much reason for this. Avoid naked light and avoid blasting, and you avoid explosion. This logic is undeniable. But the chemistry of the mine is not the matter which most directly presses upon the miner. The mechanic, the physiologist, the optician, each has to be consulted. Grim fact shows that the chemical danger is, and always has been, affronted. The need of light explains why this has been the case. What, then, is the outcome of the whole inquiry?

It is this: The miner requires light. It is now half a century since science has done much to aid him in this respect. It was in or about the year 1815 that Sir Humphry Davy and George Stephenson entered on their honorable rivalry as to the safety-lamp. Foreign engineers have provided, in the lamps used in the deep Belgian mines, a sort of compound of the "Geordie" and the "Davy," under the name of the Mueseler lamp. MM. Liaute and Denoyel have invented an electric lamp, perfect as a scientific toy, but too cumbersome and liable to derangement for the rough usage of the miner. What is required is a lamp which shall at the same time give abundant light and afford perfect protection. It must not be cumbersome; it must not be heavy; it must not be costly. Miners have been known to dash in pieces the Upton and Roberts safety-lamp, merely from the irritation caused by its weight. If the miner can be provided with a lamp which, with the safety and the convenience of the "Davy," can give the light of eight or ten candles, can throw that light where it is wanted, and can do that at a moderate cost, the saving of life in our coal mines will be very great. For, by such an appliance, not only may the mortality caused by explosions be prevented, but that due to falls of roof, if not to other causes, may be most materially diminished.

This points to the inquiry, What is the true source of light? From what materials, as matter of principle, and apart from any question of the state of the science of illumination at the moment, is artificial light more certainly to be obtained?

To that question the reply is simple. We know, as matter of chemistry, what kind of combustion produces the greatest amount of light, as we also know what produces the greatest amount of heat. The two are by no means identical. Light can not be produced without the liberation of heat. On the other hand, a very high degree of heat can be developed when little or no light is produced. As matter of principle, this is the key to the question now to be reviewed.

We need not at the moment step aside to inquire into the future of the electric light. As to the cost at which that elegant source of concentrated brilliancy may be maintained, we are in the way of having experimental proof. The first great trial in London, that of the Jablochkoff candles at Billingsgate Market, has proved a failure, as regards both the quantity and the quality of the light produced, as well as with reference to the cost of production, and has in consequence been abandoned. But, be the cost of producing an equal quantity of light by the new or the old fashioned process of combustion the greater, the former is out of the question as far as coal mines are concerned. A brilliant light at the bottom of the shaft would of course be a great desideratum. But no one who has studied the plan of the workings of a coal mine can fail to be aware that nothing will supersede the miner's lamp. Each man who works at the face must be provided with his own light; and no general illumination, were such possible, would make up for the want of this. In vast underground caverns, such as that of the Peak, in Derbyshire, or such as those of some of the Cheshire salt mines, a brilliant and concentrated light may, no doubt, be extremely effective. But in speaking of the working of collieries, whether in the "long wall" system or on any modification of the "pillar and stall," we must look to such a lamp as each miner can carry for himself.

In speaking of illumination, we are as yet without any unit of light. Our measurements in this respect are made pretty much by rule of thumb. The sperm candle, burning or supposed to burn at the rate of one hundred and twenty grammes per hour, is our nominal unit. In ascertaining the illuminative power of gas, two of these candles are used by way of measure. But there is no check as to the accuracy of their consumption. The use of a screen made diaphanous in one portion by a little grease enables the analyst to form a very accurate appreciation of the illuminative power of two lights. The screen is placed between the two, and moved backward or forward until the spot caused by the grease vanishes, which is the case when the intensity of the transmitted is exactly equal to that of the reflected light. By accurately measuring the distances, and applying the rule that the

intensity of the radiant center is inversely proportionate to the square of the distance from the screen, a very reliable comparison is attainable. But the weak point is the variable and ill-defined character of the unit of comparison. In the French experiments this defect is to a great extent avoided by the use of a Carcel lamp, which not only is intended to consume a given quantity of oil per hour, but is further weighed at the commencement and at the close of each observation, so that a correction is made in case of any variation in the actual combustion. Still, the Carcel lamp is an arbitrary unit. It is equal to about 9·6 English standard sperm candles; but when we have said that, we have only compared one arbitrary unit with another. In the case of the unit of heat, although it has been arrived at in terms of capacity (as regards the water heated) and of Fahrenheit's thermometer, which is in itself an arbitrary scale, it so happens that the Joule equivalent is exactly equal to the quantity of heat that is liberated by the combustion (if chemically perfect) of half a grain of carbon. If we take the same unit for the measurement of light, it must further be specified that the combustion of the carbon must be so effected as to produce carbonic acid and not carbonic oxide, and that it must take place in atmospheric air, and not in pure oxygen, or any other medium. That being borne in mind, it is probable that the combustion of a definite quantity of carbon would prove a better measure of light than any that has yet been tried. It would, at all events, link the phenomena of luminiferous to those of calorific combustion, and afford a ready means of detecting waste of illuminative power.

Various analyses have been given of ordinary coal-gas. Indeed, not only does that gas vary according to the quality of the coal from which it is produced, but it differs according to the process by which it is produced from coal of the same quality. Experts are divided, for example, as to the degrees of heat at which it is best to effect the distillation of coal-gas. But for our present inquiry it is enough to assume the composition of coal-gas as analyzed by Mr. Vernon Harcourt, who gives the proportions of fifty-eight per cent. of carbon and twenty-three per cent. of hydrogen. The details are given by Mr. D. K. Clark, in his invaluable work, the "Manual of Rules, Tables, and Data for Mechanical Engineers." Of this gas thirty cubic feet, at the temperature of 62° Fahr., weigh one pound. And the heating power of one pound of this gas (chemically speaking) is given by the same analyst at 22,684 British units of heat, of which sixty-three per cent. is due to the combustion of the hydrogen, and thirty-seven per cent. to that of the carbon. It thus follows that coal-gas is far more highly effective as a fuel than it is as a source of illumination. Other analyses give a yet higher proportion of hydrogen, the heat-giving element.

There is, however, a mineral fuel in which this distribution of the elements is very different. Petroleum is a natural fluid, consisting of hydrogen and carbon, which has been distilled in the great laboratory

of nature, and which exists in large quantities in various parts of the world. It is, comparatively speaking, a very recent discovery. The first well was sunk in Pennsylvania in 1858. The first "flowing well," or bore hole from which the rock oil flows naturally, dates in 1861. From that date the annual production has increased with marvelous rapidity. In 1878 it was computed that several hundred million gallons were annually raised, although only about one-half per cent. of the 2,000 square miles of area in which the mineral oil is to be found was then worked. The oil is also known to exist in Virginia, in Ohio, in Kentucky, in California, in Canada, in South America, in China, in Japan, in Java, on the north coast of Africa, in Italy, France, Austria, Wallachia, Turkey, and Russia. There is every reason to suppose that an unfailing supply might be obtained by boring in the valley of the Jordan, in which rapid stream masses of bitumen are often found borne down to the salt waters of the Dead Sea. On the shores of the Caspian it is found in such abundance that it is used as fuel for steamers. At Cheeriley, about twenty-five miles to the west of Kertch, it is stated by Mr. Ross* that there are five wells owned by an Englishman, two of which produce about one hundred and thirty-five barrels of petroleum daily. Bitumen and bituminous shales producing oil are to be found in every country of Europe, and there is good reason to suppose that the existing stores of the liquid mineral are no less ample than those of the solid beds of coal.

As to cost, the crude petroleum oil is sold at the mouth of the wells, in Pennsylvania, at from 10*s.* to 15*s.* per ton, or from $\frac{1}{2}d.$ to $\frac{3}{4}d.$ per gallon. The refined petroleum at New York is worth about 6*d.* per gallon, but half of this is the price of the casks or other vessels that contain it. If a large and steady demand were to set up, it would be easy to construct ships of which the hold should be composed of a series of air-tight compartments, in wrought iron, into which the oil might be turned directly by means of mains, like gas or water mains in our cities, and from which it might be pumped on its arrival in the Thames or in the Mersey. The cost of the delivery of this liquid fuel may thus be expected to be, hereafter, less per ton than that of coal. It only needs the first expense, that of sinking the shaft. It will then mine itself, raise itself, carry itself, and may be made to load itself on shipboard. As to the cost of the process of refinement, we are without adequate information. But, in the event of a brisk demand for the refined oil, there can be little doubt that the usual course of manufacturing industry would be followed, and that an economical method would be applied.

It is thus of interest to compare the respective properties of coal, coal-gas, and petroleum, both as regards their lighting and their heating capacities, as far as the present state of definite scientific information attainable will allow us to do so.

* "Minutes of Proceedings of the Institution of Civil Engineers," vol. xl., p. 150.

Coal has now receded in England to the old minimum price of 4*s.* 6*d.* at the pit's mouth. Some of our northern railways are paying 6*s.* a ton for coal. The price of the best Wall's End coal delivered at private residences in London, at the end of January, 1879, was 29*s.* per ton. Thus, even in the three hundred miles which divide the metropolis from the pit's mouth, it will be seen that the price of coal is so regulated by local conditions, and distance from the collieries, that it is not easy to strike an average. We may therefore assume a price, equal to that of petroleum, of 10*s.* per ton, for the sake of comparison, and it will then be easy to apply the correction due to the price of coal in any particular spot. The undetermined charges for interest on capital, merchants' profits, and delivery to consumers, may also be roundly taken, for the sake of comparison, as equal for the different materials.

The cost of the manufacture and distribution of gas in London (exclusive of the cost of coal) is about twenty per cent. over the amount realized for the sale of the residual products of distillation, of course excluding the gas. 10,000 cubic feet of gas per ton is a high, though not the highest, production. The price of the residual products, as a rule, is so far regulated by the price of coal at the spot, that it is usually reckoned that the local price of gas in England is nearly independent of the local variation in the price of coal, sales balancing purchases. Thus, if we take 10,000 cubic feet of gas as costing the same as one ton of coal, we shall be within twenty or twenty-five per cent. of exactitude, as a general rule. We have, then, to compare the luminiferous and calorific value of a ton of coal, a ton of petroleum, and 10,000 feet of cubic gas, assuming the approximate price of each of these quantities to be equal.

For lighting purposes, indeed, coal is nowhere. It has been occasionally used for giving light on public works, such as railways, when it was necessary to carry them on by night. But the light of a "devil," or iron basket of live coals, is fitful and costly. As recently as 1815 the dangerous Bell Rock, at the entrance to the Firth of Tay, was lighted by a fire-basket, or "chauffer," of live coals. It is stated in the "Life of Robert Stevenson," the great lighthouse engineer, that the consumption of coal in this "chauffer" was four hundred tons per annum, while the light was never reliable when most required. In violent gales the coal never burned on the windward side of the fire; and the guardian actually laid hold of the bars of the "chauffer," on the windward, to steady himself while putting on more fuel. Thus, in the direction where, and at the time when, the light was most required, it was all but totally invisible. The gas requisite to maintain a light equal to one hundred Carcel burners, or nine hundred and sixty candles, for twelve hours, is producible from half a ton of coal, as distilled in the gas-works. This would yield a splendid light (if the locality were such as to allow of its introduction); while the consumption of twenty-two hundred weight per night of coal only made darkness visible.

As to the calorific properties of coal, it is well known that the theoretic quantity of heat that should be chemically liberated by the consumption of a given quantity of that fuel is more than ten times as much as that which is ordinarily obtained, even by well-constructed steam-boilers. For a pound of coal to evaporate eight pounds of water may be taken as a very favorable average. In domestic consumption there is nothing approaching to this economy of heat. A considerable quantity of unburned carbon passes up the chimney in the form of smoke; and probably three fourths of the heat actually liberated by combustion is carried off in the same manner by the draught.

According to the experiments made by Mr. Vernon Harcourt, before referred to as quoted by Mr. D. K. Clark in his "Manual of Rules, Tables, and Data," a pound of gas, with a volume of thirty cubic feet, will evaporate thirty pounds of water from 212°, or 21·4 pounds from 62°. This gas is reckoned at 9,000 cubic feet to the ton of coal; so that the evaporation (of one pound of water by one cubic foot of gas) is effected by the quantity of the latter derived from almost exactly a quarter of a pound of coal. At the more ordinary allowance of 10,000 cubic feet per ton, ·224 pound of coal yields a foot of gas. It has to be borne in mind that only about thirty-six per cent. of the coal ordinarily used for gas is volatilized in the process of distillation. Of the coke, which is the chief residual product, from fifty-eight to ninety-three per cent. is carbon; sulphur and other impurities going to make up the rest of the bulk. There are produced on the average thirteen and one-half hundred weight of coke, and ten gallons of tar, from a ton of coals, besides the gas. The calorific and luminiferous values of these residual products are thus much greater than that of the gas itself. But a better use can be made of tar than to burn it; and we have considered the value of these products as absorbed by the cost of the process of making gas.

With these qualifications, the calorific effect of the gas produced from a pound of coal is about half that which would be produced by the burning of a pound of coal under a well-constructed boiler, where of course both coke and tar are consumed together with the gas. But in cases of domestic consumption the economy in the use of gas will be immense. There is no waste, no smoke. Instead of seventy-five per cent. of the heat going up the chimney, nearly all will be directly utilized. There is no loss of heat in lighting the fire; none in cooling when the work is done; no labor in the carriage of coal to the furnace; none in the removal of the ashes. Bearing in mind all these sources of economy, the domestic use of gas for heating purposes is so advantageous that it is extraordinary that the introduction of so clean, cheap, and manageable a source of comfort should make such slow progress in England. In America the improvement is more rapid and more general.

For luminiferous purposes we have seen that there is no comparison between the consumption of crude coal and that of coal-gas. Allowing the mean proportion of 10,000 cubic feet of gas to the ton of coal which we have before taken, the consumption of an ordinary gas-burner, whether an argand or a fish-tail, is about five cubic feet per hour, giving a light of from twelve to sixteen candles, according to the richness of the gas. If we take Mr. Vernon Harcourt's analysis, thirty cubic feet, or one pound of gas, contains 4,060 grains of carbon. Five cubic feet therefore contain 67·6 grains, which will be the hourly consumption of pure carbon in an ordinary gas-light.

Petroleum, however, contains from eighty-two to eighty-seven per cent. of carbon, and from eleven to fifteen per cent. of hydrogen. Averaging this at eighty-four per cent. of the former and thirteen of the latter, a pound of petroleum contains 6,080 grains of carbon and 910 grains of hydrogen. Its luminiferous power is thus almost exactly fifteen times that of coal-gas, taking equal weights. Its calorific power, supposing a perfect combustion, will be ten per cent. less than that according to Mr. Vernon Harcourt's estimate, and less than half that of the highest estimate given by Mr. Clark.

It is thus as clear as any deduction from chemical data can be, that while the economy in the use of coal-gas as a source of heat is so great as to render it worth while to keep up the distillation of this product, as now carried on, for calorific purposes alone, even exclusive of its use for a light, for the purposes of illumination petroleum offers an immense advantage over coal-gas, its illuminating powers being as much as fifteen-fold. And when we are speaking, not of an organized system of fixed lights, but of the convenience of a hand lamp, the price and the illuminative value of petroleum indicate it as the source of the economical light of the future. In fact, its light-giving power is ten per cent. more than that of either tallow or olive-oil, and four per cent. more than that of wax, weight for weight, notwithstanding the great difference in price.

The question of the miner's safety, then, resolves itself into the construction of a petroleum lamp, which shall have the safety of the "Geordie," while giving the light of one, or even of two or three fish-tail burners of gas, and which shall be so made as neither to empty nor to be extinguished if laid on the side.

It is desirable, in an inquiry of this nature, to avoid anything that assumes the appearance of advertisement, or of an attempt to introduce anything of a commercial bearing. For that reason less must be said than honestly and fairly might be said as to the principles on which such a lamp may be unquestionably constructed. Two or three patents exist, which would require due consideration. It is always, indeed, doubtful how far recent patents will stand the test of thorough investigation. The latest patents for electric lighting are now found, in many cases, to be reproductions of methods long since introduced and

abandoned. Moreover, it may be hoped that if it were found that a great national benefit, such as a true miner's lamp would be, involved either a long delay before it could be offered to the collier, or serious compensation for an unexpectedly valuable patent right, no very exorbitant claim would be raised to avoid the saving of a human life per day.

The one simple principle on which a lamp, whether a safety-lamp or any other, may be made to yield the full light due to the perfect combustion of the carbon of its aliment, is one long known to the miner as applied to ventilation. A single shaft will not ventilate a mine. In the same way, if a lamp or a candle be surrounded by a glass shade only open at the top, it will not burn properly. The taller the glass chimney the redder and dimmer will be the flame, until it is actually extinguished by the product of its own combustion. This is usually avoided by a free admission of air below the chimney, which is not practicable in a safety-lamp. But if for one shaft two be substituted, or even if the single shaft be divided—the miners call it "bratticed" —into two vertical sections, a little heat will produce an upward current in the one, which will be fed by a descending current in the other. The lamp is only the mine in miniature.

Very brilliant results have already attended the introduction of a lamp constructed in accordance with this simple law, in the illumination of railway carriages. No mechanical man can doubt that a modification of the lamp now used in the royal saloon carriages might put in the hands of the miner a real life-preserver. It would be a lamp which, while impenetrable to fire-damp, or rather impenetrable from within as a source of explosion, would give him what he now wants—light in the darkness of the mine.

We have seen that, out of the half million of colliers, to whose perilous labors we owe the warmth and comfort of our homes, the speed and regularity of our traveling both by land and by sea, and the aliment of that mighty host of mechanical horses which now perform the bulk of the sheer hard labor required above-ground in the United Kingdom, a tax on human lives at the rate of at least ten lives per million tons of coal is exacted with much regularity. From a fourth to a half of these lives are sacrificed by preventable calamities. It is by satisfying the mute instinctive demand of the miner for light, in his painful and dangerous toil, that these casualties which are preventable can alone be certainly prevented. Is it necessary to say more in order to turn the attention of the collier and of the engineer, of the man of capital and of the man of science, of the economist and of the philanthropist, to the urgent question of providing the miner with a safe, convenient, and luminous lamp?

P. S.—Since the above was in type, has appeared the announcement of a Royal Commission of Inquiry into Mining Explosions, to the attention of which the above remarks may be respectfully commended.—*Fraser's Magazine.*

CHEMISTRY IN ITS RELATIONS TO MEDICINE.*

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IF we look back over the field of chemistry, we find that we can easily discern well-characterized periods in its development. At first, in this subject, as in all others, came the period of chaos, during which relations of similar facts were not recognized nor suspected. No defined object was in view; and the development during this period was due almost entirely to accidental observations of facts which presented themselves to men in pursuing their ordinary occupations. Gradually we find that a certain class of men began to make use of chemical facts, as far as they were then known, for a very definite purpose. This was, to convert ordinary base metals into that metal which possessed the greatest value—*gold*. This purpose gave a powerful incentive to the study of chemical phenomena, and, under the influence of the natural passion which affected a comparatively large number of men, the subject of chemistry grew apace. But the impossibility of accomplishing the great problem of the alchemists became more and more apparent. No gold *was* made from baser metals, and no genuine philosopher's stone was discovered; no panacea for all diseases was revealed. A reaction in scientific opinion then began, which led to very much modified views concerning the purpose of chemistry, until about the time of Paracelsus, who was both physician and chemist, we find that the opinion prevailed very generally, among those who were most active in investigating chemical phenomena, that the changes which take place in the animal body, under normal conditions, are nothing but chemical changes; that a disturbance of these normal changes causes the different varieties of disease; and, finally, that the treatment of disease must consist in administering such chemical substances as would restore the normal conditions. Paracelsus started these ideas, and others developed them, until they took the exaggerated form comprised in the above statements. According to these ideas, medicine was considered as a branch of chemistry, very much as metallurgy is now considered as a branch of chemistry. Hence the physicians of the date of which I am speaking—i. e., from the early part of the sixteenth until some time in the seventeenth century— regarded chemistry as the one important subject for those who were to deal with disease. Without a knowledge of this subject they could not comprehend the processes of life; without it they could not understand disease; without it they could not intelligently administer remedies.

* From the Annual Address delivered before the Medical and Chirurgical Faculty of Maryland.

I think we can see, in this reference to history, a tendency which has frequently been repeated since that time—a tendency to generalize upon an insufficient basis of facts concerning the action of remedies. The reasoning of these older physicians, stripped of all unnecessary details, was simply this: Some remedies act chemically upon the body and produce chemical effects, hence all remedies must act in the same way. Thus the chemico-medical school was founded, as many schools of medicine have since been founded. The dogmas of this old school contained a healthy nucleus of truth, to be sure, as do the dogmas of most schools of medicine existing at the present day, but the physician proper now recognizes that remedies act in very many ways, and that the science of medicine must take into consideration every way in which remedies can act. He does not commit the error of being satisfied with one idea, as, for instance, that substances do act chemically upon the body, that cold water is a valuable remedy, that electricity properly applied is at times beneficial. A single idea is not sufficient for him.

Still we must recognize the fact that, in order to impress upon the minds of men the importance of an idea, in order to attract attention to it, it is frequently necessary to present it in an exaggerated form. And so, while we see the error of the old physiciansof Paracelsus's time, we see also that, by attracting the attention of physicians and chemists to the connection between chemistry and medicine, the error committed resulted in permanent good to medicine, and the influence of the old school is still felt. The ideas of those who founded and developed the chemico-medical school have found their proper level, as all ideas tend to do sooner or later.

It would doubtless be interesting to follow closely the history of the connection between chemistry and medicine, but our time will not permit the discussion of this subject, and hence I shall speak of the bonds of connection indicated by actual chemical work of the present day.

In the first place, chemistry furnishes medicine with many of its valuable remedies, as every one knows. The chemist, however, does not recognize the discovery of new substances, possessed of medicinal properties, as the object of his work. If he did so, both chemistry and medicine would suffer. The prime object of the scientific chemist must always be to develop his science, to perfect it in every way he may find possible; he must be constantly on the lookout for discrepancies between facts supposed to be established, and must ever endeavor to correct errors into which his predecessors may have fallen; he must reach out beyond that which is known, and strive to know more. The object of the chemist can only be accomplished by employing every method peculiar to the science of chemistry, and by striving to know everything about a substance or class of substances which it is possible to discern. If the chemist should work with the main object of adding

to the valuable substances included in the materia medica, he would stop when he had established the fact that this substance—just born—has such and such medicinal properties. He might discover a few substances in this way, but, unless work of another kind were going on simultaneously, which would furnish him with new methods, with new guiding principles, the possibilities of new discoveries would soon be exhausted. It is absolutely necessary, then, that purely scientific and abstruse problems should engage the attention of chemists, if the science is to grow; and it is further necessary that the science should grow, in order that new methods for the discovery of new substances may be introduced. It is the chemist proper who furnishes the new method; it may be that the chemist proper also discovers the valuable remedy, though one who simply applies the truths of chemistry *may* make the discovery.

As a matter of fact, it can be shown that it is to the purely scientific chemist, working with the main object of building up the science, that we owe the discovery of most valuable remedies, at least of those which are strictly speaking chemical compounds. I select for this purpose two substances which have but comparatively recently found their places in the materia medica—viz., chloral and salicylic acid. How and by whom were these substances discovered and introduced into medicine?

Nearly fifty years ago the great master Liebig undertook the study of the decomposition which alcohol undergoes when treated with chlorine. Other observers had noticed the fact that alcohol is decomposed by chlorine and that an oily product is formed, but the nature and composition of this product were unknown. Liebig undertook then simply to study this decomposition for the sake of throwing light upon the general subject, the action of chlorine upon alcohols. His investigations soon led him to the discovery of a new substance which possessed peculiar chemical properties, distinguishing it from all other compounds then known. This was *chloral*—the name being derived from the first syllable of *chlor*ine and the first syllable of *al*cohol. Of the action of this substance upon the system, Liebig did not dream; but the study of its properties which he made at that time furnished the material that enabled Liebreich, forty years later, to dream in a very rational manner concerning its action upon the system. Liebreich's discovery of the value of chloral could not have been made by one unversed in chemistry. His experiments were undertaken in the true scientific spirit, and were suggested by a purely chemical method of consideration.

Among other facts concerning chloral which had been established by Liebig was this that in the presence of alkalies it breaks up into formic acid and the substance which we now know by the name chloroform. Chloroform was thus discovered by Liebig at the same time with chloral, but the action of the former upon the system was as little

known as that of the latter. Years after the effects produced by the inhalation of chloroform were discovered, Liebreich reasoned thus: If chloral breaks up in alkaline liquids into chloroform and formic acid, why should it not break up in the same way when introduced into the animal system? The conditions in the body are favorable for such a decomposition—the blood is an alkaline liquid and the chloral will dissolve in it. By means of this reasoning the discovery was made, and there is no cause to doubt that the beneficial effects experienced from chloral are due to the fact that the alkaline blood decomposes it, forming chloroform and formic acid, the chloroform being thus introduced into the system in a manner differing from that involved in the inhalation process.

As regards salicylic acid, its discovery was the result of a long series of purely scientific investigations. For years Kolbe had been trying to produce artificially in his laboratory some of the substances which are found in nature. He strove faithfully and conscientiously to accomplish his purpose, and at last he discovered a method which enabled him to make oxalic acid; and then, after the method was given, the production of other similar acids was simply a question of the application of the new method. Salicylic acid was among the products thus formed. The acid had been known for a long time, but, as it could be obtained only from the expensive oil of wintergreen, it belonged to the rare substances. Kolbe's method of preparation, however, furnished the substance in large quantities and at a low price.

The discovery of the valuable antiseptic properties of the acid was a pure scientific discovery, and was due to purely chemical reasoning. It was known that salicylic acid when heated breaks up directly into carbolic acid and what is commonly called carbonic acid. It occurred to Kolbe that possibly this property might be taken advantage of to furnish a substitute for the objectionable carbolic acid. The results of his experiments are well known: they were more satisfactory than he had hoped for. He found that salicylic acid is an excellent antiseptic. Though he has shown that, contrary to his expectation, the antiseptic action possessed by the acid is not due to its breaking up into carbonic and carbolic acid, still the action must be due to a similarity between the chemical structures of the two acids; and this similarity could not have been detected without the aid of some of the most refined methods of scientific chemistry. It is safe to say that blind experiment, unguided by definite chemical principles, could not have led to this discovery.

Thus I have at least illustrated the truth of the remark I made a few minutes since, to the effect that the discoveries of substances valuable in medicine are made by those engaged in the pursuit of pure science. I am aware that the two examples thus referred to will not suffice to furnish a perfect proof of the proposition; but, if time per-

mitted us to take a survey of the field, we should find that the proof could be made conclusive.

But the discovery of new substances to be used as remedies does not furnish the only bond of connection between medicine and chemistry. Nor is it by any means the most important one. For, as the tendency of the present generation of physicians is, I think, to rely less and less upon the action of drugs and chemicals, and to pay more and more attention to the circumstances surrounding the patient, so the discovery of purely remedial agents is becoming day by day of less importance, and the accurate study of those substances which we all necessarily make use of—air, water, food in its various forms—is becoming the great problem in medicine. Thank Heaven! the day of the old woman who knows what is "good for" everything is waning. She exists still in a thousand forms, sometimes in skirts and sometimes in trousers, but the natural growth of modern ideas will eradicate her, though the process will take generations for its completion.

What is pure air? What is pure water? What food is appropriate? These are questions which can only be answered by him who is versed in chemistry. The very fact that discussions are still going on in regard to these subjects indicates clearly that they can not be answered easily, and yet no one doubts their fundamental importance.

For years men were satisfied with the belief that an increase in the amount of carbonic acid, beyond a certain point, was the cause of the evil effects experienced in breathing "foul air." The old familiar stories that have been told to prove the injurious character of the gas are still told in lectures on chemistry, and text-books of chemistry, and in medical books without number. Still, as most of you probably know, it has long since been proved by direct experiment, beyond the possibility of a doubt, that the amount of this gas may be increased to one twentieth of the volume of the air without producing any serious or even disagreeable effects upon those who breathe the air thus contaminated. This is true, however, only when the carbonic acid is mixed with the air as a pure substance. If introduced in the ordinary way, by the breathing process, different results are obtained, and it is found that, under these circumstances, the quantity of carbonic acid can not exceed one part in 1,000 of air without serious effects upon those who breathe the air. The two results, apparently, do not harmonize, but, when we recognize the presence of other substances, of organic matters, in the air, which are given off from the body together with the carbonic acid, and in quantities proportional to the quantities of the latter, we can readily see that there may be some connection between the amount of the carbonic acid present and the fitness of the air for breathing purposes. Such organic matters can easily be detected in the air, and they have recently been found by a method which indicates the possibility of determining their quantity, though such determinations are, at present, far from possible. Air was passed through

a heated tube, and then passed into alcohol for the purpose of retaining the products formed by heating the organic substances. The alcohol gradually changed its color and became dark brown. This experiment, though exceedingly imperfect, at present points, I think, to the possibility of estimating the purity of air by a direct determination of the quantities of those constituents which probably are the really injurious ones; while, at present, for the want of a more reliable method, we are obliged to be satisfied with determining the quantity of carbonic acid, and then drawing conclusions with reference to the amount of the organic matters present.

Various attempts have been made to simplify the determination of the amount of carbonic acid in air, so that even those who are not skilled in chemical manipulation might have a ready means for pronouncing upon the quality of air. The simplest of the methods proposed is the minimetric process of Lunge, which has been used to some extent in this as well as other countries. To show you, however, in what an unsatisfactory state this matter of air analysis still is, I will simply say that experiments undertaken, within a few months, by Hesse,* have shown that Lunge's minimetric process does not give reliable results, and hence conclusions reached from determinations made by this method are not to be regarded as final.

Another point still in dispute concerns the presence of carbonic oxide in the air. This lower oxide of carbon is undoubtedly poisonous, and can not be taken into the lungs without serious effects. The presence of only a small proportion of this gas will suffice to produce death. Now, if it could be shown that there are certain causes at work which apparently tend to introduce the gas into our dwellings and other buildings, alarm would naturally follow. Some years ago St. Claire-Deville, the French chemist, discovered that certain metals, when heated to red-heat, are porous for certain gases. This he found to be true of cast iron with reference to carbonic oxide. It is well known that in our coal-fires there is always formed a large quantity of carbonic oxide; and, further, that stoves and furnaces not uncommonly become red-hot. Putting these facts together, men became alarmed. Stoves and furnaces were regarded with horror. In the eyes of many they were looked upon as poison-generators of a very dangerous kind. Active diseases were, in some cases, believed to have their origin in the presence of carbonic oxide in the air; and, in cases in which active disease did not show itself, lassitude, headache, and other similar symptoms were supposed to be caused by the gas. There was a fashion, in some places, and particularly among those who prided themselves on "keeping up with the times," of referring every bodily affection to carbonic oxide when no other cause could be thought of, very much as, in days gone by, every disease which was not understood was classed under the general head "trouble with the liver."

* "Zeitschrift für Biologie," Bd. xiii., 395.

What basis of facts have we for this alarm about carbonic oxide? Two chemists, within a very short time, have gone to work to determine the amount of the gas contained in the air in places where it was assumed to be present in considerable quantity. And with what results? Why, the specter vanished. In vain they sought for it—in this corner, in that, in the chimney, in the hot-air passages—but it was not there. There seems to be nothing left for the carbonic-oxide alarmists but to yield, and set about looking for another cause.

The special experiments to which I refer were carried out by Gottschalk in Leipsic, and Vogel * in Berlin. Gottschalk, in a pamphlet entitled "Ueber die Nachweisbarkeit des Kohlenoxyds in sehr kleinen Mengen, und einige Bemerkungen zu der sogenannten Luftheizungsfrage," describes a process by means of which he could detect, as he shows by direct experiment, 0·22 part of carbonic oxide in 1,000 parts of air. He was commissioned by the authorities of the city of Leipsic to apply this process to the examination of the air in two of the public schools in the city. Two different kinds of hot-air furnaces were employed in these schools, and it was supposed that the air of the rooms was certainly contaminated with carbonic oxide. The experiments, however, proved that, if present at all, the gas could not be detected by a method capable of determining with certainty the presence of ·22 part in 1,000.

Vogel's experiments are not so delicate as those of Gottschalk, but still they are interesting for other reasons. His method consists in shaking the air under examination with water which contains a drop or two of blood, and then examining the liquid by means of a pocket-spectroscope. If ·4 per cent. of carbonic oxide be present the result is plainly perceptible in the spectrum of the light which has passed through the blood. The authorities of the city of Berlin commissioned Vogel, together with two other well-known experts, to examine the air of a number of schoolrooms in the city, with particular reference to the presence of carbonic oxide. The conclusion was simply that none of the gas could be detected by the blood method. Vogel argues further that a quantity of carbonic oxide in the air which can not be detected by his method can not act poisonously upon the concentrated blood of the human lungs.

Of course the experiments described do not prove conclusively that air is not sometimes rendered unwholesome by carbonic oxide, but they at least prove that this gas is not so widely distributed as it has been supposed to be for some time past.

Another constituent of the air which has from time to time attracted considerable attention is ozone. This has been supposed to be a health-giving principle in the atmosphere, and magical properties have been ascribed to it. The vitality of men is known to be subject to marked variations. On a cool, clear, bracing day the man is not

* "Berichte der deutschen chemischen Gesellschaft," xi., 235.

what he is on a warm and murky day. The quantity of ozone in the air also varies. Perhaps our moods, our "spirits," are dependent upon ozone. Give us ozone enough, and the world will be happier and healthier. These are some of the ideas which have been advanced. Possibly there is some connection between these two very unlike things. Certainly much more accurate experiments than any which have thus far been made, are called for to prove the connection.

In the light of many experiments it appears exceedingly probable that one of the most important constituents of the air is aqueous vapor, and that variations in its quantity beyond certain limits are productive of serious results. The influence of carbonic acid, carbonic oxide, or ozone, upon the value of air is almost nothing as compared with the influence exerted by the moisture. This is a point that does not ordinarily receive the amount of attention which it deserves. A reliable hygrometer should be as frequently used in a dwelling as a reliable thermometer. It is undoubtedly a very difficult thing to regulate the amount of moisture in the atmosphere of dwellings, but more could be done than is done. The methods now adopted for this purpose are mostly exceedingly imperfect. Further, the importance of doing everything to regulate the amount is not sufficiently recognized, at least by the people at large.

As regards the water we drink, every one knows that cases are very common in which it becomes polluted in one way or another, and that disease results from its use. Innumerable chemical examinations of drinking-water have been made, and large numbers of methods proposed for the analysis. Some of the methods have been shown to be utterly unreliable; others to be questionable; very few indeed to give results which can be regarded as at all valuable. It is about as difficult at the present day to say what pure water is as it is to say what pure air is. Papers upon papers are written on the subject of water analysis. Some of these are based upon experiments performed; some are simply critical. Out of the mass of literature we gather some truths. One that stands out prominently is this, that the presence of chlorine, of organic matters, of ammonia, and of so-called "albuminoid ammonia," indicates that the water containing them is very probably contaminated through sewage, cesspool, privy, or barnyard refuse. By the later methods of analysis, the estimations of the quantities of the substances mentioned have become comparatively simple processes, so that now it is undoubtedly possible to pass a fairly reliable judgment upon the value of a given specimen of water. It is, however, still quite impossible to determine by chemical methods whether the typhoid-poison is present in water or not, just as it is still impossible to determine whether in the air there is present that indefinite something known as "malaria." There is still a great deal to be done in order that a close connection between disease and the condition of drinking water may be established. The open questions are to a con-

siderable extent chemical questions, and they must be answered by the chemist. But new methods must be introduced of a more refined nature than most of those in use at present, and these methods will probably be discovered in paths leading far away from the field of mediicne proper.

There is a deep question of great importance to the physician involved in the study of food: What food should this or that person indulge in? Every physician knows that the whole subject of food is at present in an indefinite, unsatisfactory condition. Fashions change in regard to kinds of food considered advisable. Now it is raw beef, now milk, now certain vegetables, etc. Of course, there is always a good reason to be given for the advice, whatever it may be, but it is certain that a good firm basis is still wanting for an understanding of the needs of the body under different conditions. Here is a great field for investigation; and Voit, of Munich, is doing what it is possible for a man to do in this direction.

But, aside from the deeper question which chemistry must answer as to the requirements of the body in the way of food, another question, which presents itself at once to the physician and chemist, concerns the adulterations of food. Very little of a general character can be said in this connection. It is, of course, the duty of the physician to see that the food partaken of is what it ought to be. That adulteration of various kinds of food is a frequent occurrence can not be doubted. In despotic countries, inspectors of food are appointed, and heavy penalties are imposed upon those who sell adulterated articles. We can hardly hope ever to have such strict regulations in regard to these matters in this country. The free-born citizen, especially if he be a manufacturer or dealer in suspected articles, naturally rebels against interference with his rights; and the manufacturer is not to be treated lightly. His voice is loud in the halls of legislation; and, what *he* does not want, the average legislator is pretty sure not to want. The relations with reference to food adulterations are similar to those existing with reference to fertilizers. The value of many fertilizers depends upon the amount of phosphoric acid and ammonia contained in them. I know that in some places there are chemists who habitually find considerably more phosphoric acid and more ammonia in any given fertilizer than it actually contains. If a young chemist dares to find the amounts actually present, and to state the results, the manufacturer discards them, and takes the highest and false ones obtained by the initiated chemist. This can only be characterized by the name swindling. The public must submit. The manufacturer's interests are not to be trifled with. Looking at the subject of food adulterations from the standpoint of the public, it can only appear highly desirable that some action should be taken by our State governments looking to vigorous interference with the traffic in impure and injurious substances.

Having thus touched upon the general subject of the relations of chemistry to materia medica and to hygiene, it remains for me to consider briefly the relations between chemistry and medicine in a deeper and broader sense. We can not at the present day, like our predecessors, regard medicine as a branch of chemistry. There are many kinds of action, not chemical, which must be studied and understood by the physician. Still, undoubtedly many of the physiological processes are essentially of a chemical nature, and there are many pathological phenomena which are also chemical. The complex organism which is the physician's field of work employs a variety of forces, prominent among which is the chemical force. It would be a trite remark to say that the physician can not possibly have a complete comprehension of what is going on within the body without a fair knowledge of chemistry. Yet I fear this fact is not always fully realized, nor indeed generally, if we are to take as evidence the practice of most medical schools.

Writing a quarter of a century ago, Liebig used these words, which I can not do better than to repeat: "Physiological and chemical researches in the field of medicine are only in their infancy, but scarcely begun; they have furnished the conviction that the processes in the living body rest upon natural laws, and every day brings discoveries, which prove that these laws can be investigated. It is true that in ages gone by there were excellent physicians who knew nothing of anatomy, and that for centuries diseases have been cured, the nature of which was not understood, just as to-day the nature of 'fever' and 'inflammation' is not known; but there is not the slightest foundation for the conclusion that an exact insight into these processes is impossible." And again he says: "Without correct ideas in regard to force, cause, action; without a practical insight into the nature of natural phenomena; without a thorough physiological and chemical training, it is no wonder that otherwise sensible men defend the most nonsensical views."

These words of Liebig are just as forcible to-day as the day they were written, and just as applicable.

The special value of a training in chemistry for a physician does not necessarily depend upon the fact that he learns a host of useful things, that he learns how to analyze substances, etc. To be sure, these acquisitions are valuable to him. But, if chemistry is to do for him what it can do, he must work so long and so conscientiously in its field as to enable him to acquire the "chemical sense." He must learn to think in the language of chemistry. He must reason as chemists reason—not as deeply, of course, but in the same general way. Then chemistry will be to him a constant aid, whose presence he will feel whenever he is brought face to face with life, either in its normal or its abnormal forms.

But, even if he did not retain a single chemical fact, the training

which he would receive by going through a course in chemistry would be of value to him. His eye and mind would become somewhat accustomed to dealing with natural phenomena. His powers of observation would be exercised, and a certain ability to distinguish between the important and that which is secondary would be cultivated. With such preparation, and other appropriate accompanying preparation, he would be much better able to undertake the study of medicine proper than without it. Hence it is much better to introduce the study of medicine by that of chemistry and other allied subjects, than to take up all the subjects together. The study of chemistry should form a part of the preliminary, fundamental training of every medical student.

That, owing to the arrangements of our medical schools, very little time can be given to chemistry is a misfortune. The amount of the subject usually taught is scarcely worth the trouble of acquiring it. I know what the amount usually is. I remember distinctly that, on the occasion of my graduation as a doctor of medicine, I was asked six questions which any one who had ever looked at a text-book of chemistry could have answered. I answered most of the questions incorrectly, as I have since discovered, but the Professor thought I was right, and I thought so too, and that was all that was necessary. Instead of possessing the "chemical sense," I was the possessor of considerable chemical nonsense.

But, while it requires no arguments to prove that a chemical training is desirable for the physician, it is not sufficient simply to acknowledge the truth of the statement. If it is true, then it is the sacred duty of every one, who has any influence with those who have a medical career in view, to put them upon the right track, to see that the best kind of preliminary training is furnished them.

By what I have said, I do not mean to imply that the physician is to be a chemist. This is an impossibility. "No man can serve two masters." I mean simply that he should have sufficient chemical knowledge to enable him to see when chemistry can answer a question of importance to medical science, and to know what value to attach to a chemical fact. It is plain that this kind of knowledge, which, so to speak, should pervade the mind of the physician, can only be acquired by studying pure chemistry as a science, and not by taking up the special study of physiological chemistry or medical chemistry. These latter rest upon pure chemistry, and can only be studied intelligently upon this basis. The specialist in medicine does not study eye-diseases or lung-diseases or diseases of the nerves, without first studying medicine. The analogy suggests itself.

But chemistry, even sufficient for the medical man, can not be studied alone by means of lectures and text-books. The medical student should be brought, in the laboratory, in direct contact with the substances, the relations and properties of which he is studying. By

this means alone can he learn enough of the subject to be of value to him; by this means alone can he get the peculiar training which leads to that kind of mind known as the "scientific mind"—a something which is tangible and attainable, and which should be a characterizing feature of every medical man.

THE HISTORY OF GAMES.

By EDWARD B. TYLOR, F. R. S.

BEFORE examining some groups of the higher orders of games, with the view of tracing their course in the world, it will be well to test by a few examples the principles on which we may reason as to their origin and migrations. An intelligent traveler among the Calmucks, noticing that they play a kind of chess resembling ours, would not for a moment entertain the idea of such an invention having been made more than once, but would feel satisfied that we and they and all chess-players must have had the game from one original source. In this example lies the gist of the ethnological argument from artificial games, that, when any such appears in two districts, it must have traveled from one to the other, or to both from a common center. Of course this argument does not apply to all games. Some are so simple and natural that, for all we can tell, they may often have sprung up of themselves, such as tossing a ball or wrestling; while children everywhere imitate in play the serious work of grown-up life, from spearing an enemy down to molding an earthen pot. The distinctly artificial sports we are concerned with here are marked by some peculiar trick or combination not so likely to have been hit upon twice. Not only complex games like chess and tennis, but even many childish sports, seem well-defined formations, of which the spread may be traced on the map much as the botanist traces his plants from their geographical centers. It may give us confidence in this way of looking at the subject if we put the opposite view to the test of history and geography to see where it fails. Travelers, observing the likeness of children's games in Europe and Asia, have sometimes explained it on this wise: that, the human mind being alike everywhere, the same games are naturally found in different lands, children taking to hockey, tops, stilts, kites, and so on, each at its proper season. But, if so, why is it that in outlying barbarous countries one hardly finds a game without finding also that there is a civilized nation within reach from whom it may have been learned? And, what is more, how is it that European children knew nothing till a few centuries ago of some of their now most popular sports? For instance, they had no battledoor and shuttlecock and never flew

kites till these games came across from Asia, when they took root at once and became naturalized over Europe. The origin of kite-flying seems to lie somewhere in southeast Asia, where it is a sport even of grown-up men, who fight their kites by making them cut one another's strings, and fly birds and monsters of the most fantastic shapes and colors, especially in China, where old gentlemen may be seen taking their evening stroll, kite-string in hand, as though they were leading pet dogs. The English boy's kite appears thus an instance, not of spontaneous play-instinct, but of the migration of an artificial game from a distant center. Nor is this all it proves in the history of civilization. Within a century, Europeans becoming acquainted with the South Sea Islanders found them down to New Zealand adepts at flying kites, which they made of leaves or bark-cloth, and called *mánu*, or "bird," flying them in solemn form with accompaniment of traditional chants. It looks as though the toy reached Polynesia through the Malay region, thus belonging to that drift of Asiatic culture which is evident in many other points of South Sea Island life. The geography of another of our childish diversions may be noticed as matching with this. Mr. Wallace relates that, being one wet day in a Dyak house in Borneo, he thought to amuse the lads by taking a piece of string to show them *cat's-cradle*, but to his surprise he found that they knew more about it than he did, going off into figures that quite puzzled him. Other Polynesians are skilled in this nursery art, especially the Maoris of New Zealand, who call it *maui*, from the name of their national hero, by whom, according to their tradition, it was invented; its various patterns represent canoes, houses, people, and even episodes in Maui's life, such as his fishing up New Zealand from the bottom of the sea. In fact, they have their pictorial history in cat's-cradle, and, whatever their traditions may be worth, they stand good to show that the game was of the time of their forefathers, not lately picked up from the Europeans. In the Sandwich Islands and New Zealand it is on record that the natives were found playing a kind of draughts which was not the European game, and which can hardly be accounted for but as another result of the drift of Asiatic civilization down into the Pacific.

Once started, a game may last on almost indefinitely. Among the children's sports of the present day are some which may be traced back toward the limits of historical antiquity, and, for all we know, may have been old then. Among the pictures of ancient Egyptian games in the tombs of Beni Hassan, one shows a player with his head down so that he can not see what the others are doing with their clinched fists above his back. Here is obviously the game called in English *hot-cockles*, in French *main-chaude*, and better described by its mediæval name of *qui fery?* or "who struck?"—the blindman having to guess by whom he was hit, or with which hand. It was the Greek *kollabismos*, or buffet-game, and carries with it a tragical asso-

ciation in those passages in the Gospels which show it turned to mockery by the Roman soldiers: "And when they had blindfolded him .... they buffeted him .... saying, Prophesy unto us, Christ, Who is he that smote thee?" (Luke xxii. 64; Matt. xxvi. 67; Mark xiv. 65).

Another of the Egyptian pictures plainly represents the game we know by its Italian name of *morra*, the Latin *micatio*, or flashing of the fingers, which has thus lasted on in the Mediterranean districts over three thousand years, handed down through a hundred successive generations who did not improve it, for from the first it was perfect in its fitting into one little niche in human nature. It is the game of guessing addition, the players both at once throwing out fingers and in the same moment shouting their guesses at the total. Morra is the pastime of the drinking-shop in China as in Italy, and may, perhaps, be reckoned among the items of culture which the Chinese have borrowed from the Western barbarians. Though so ancient, morra has in it no touch of prehistoric rudeness, but must owe its origin to a period when arithmetic had risen quite above the savage level. The same is true of the other old arithmetical game, *odd-and-even*, which the poet couples with riding on a stick as the most childish of diversions, "Ludere *par impar*, equitare in arundine longa." But the child playing it must be of a civilized nation, not of a low barbaric tribe, where no one would think of classing numbers into the odd-and-even series, so that Europeans have even had to furnish their languages with words for these ideas. I asked myself the question whether the ancient Aryans distinguished odd from even, and curiously enough found that an answer had been preserved by the unbroken tradition not of Greek arithmeticians, but of boys at play. A scholiast on the Ploutos of Aristophanes, where the game is mentioned, happens to remark that it was also known as *ζυγὰ ἢ ἄζυγα*, "yokes or not-yokes." Now, this matches so closely in form and sense with the Sanskrit terms for even and odd numbers, *yuj* and *ayuj*, as to be fair evidence that both Hindoos and Greeks inherited arithmetical ideas and words familiar to their Aryan ancestors.

Following up the clews that join the play-life of the ancient and modern worlds, let us now look at the ball-play, which has always held its place among sports. Beyond mere tossing and catching, the simplest kind of ball-play is where a ring of players send the ball from hand to hand. This gentle pastime has its well-marked place in history. Thus the ancient Greeks, whose secret of life was to do even trivial things with artistic perfection, delighted in the game of Nausikaa, and on their vases is painted many a scene where ball-play, dance, and song unite in one graceful sport. The ball-dance is now scarcely to be found but as an out-of-the-way relic of old custom; yet it has left curious traces in European languages, where the *ball* (Low Latin *balla*) has given its name to the dance it went with (Italian *ballare*, *ballo*, French *bal*, English *ball*) and even to the song

that accompanied the dance (Italian *ballata*, French *ballade*, English *ballad*). The passion of ball-play begins not with this friendly, graceful delivery of the ball into the next hand, but when two hostile players or parties are striving each to take or send it away from the other. Thus, on the one hand, there comes into existence the group of games represented by the Greek *harpaston*, or seizing-game, where the two sides struggled to carry off the ball. In Brittany this has been played till modern times with the hay-stuffed *soule* or *sun*-ball, as big as a football, fought for by two communes, each striving to carry it home over their own border. Émile Souvestre, in his "Derniers Bretons," has told the last story of this fierce game in the Ponthivy district—how the man who had had his father killed and his own eye knocked out by François, surnamed le Souleur, lay in wait for that redoubted champion, and got him down, soule and all, half-way across the boundary stream. The murderous soule-play had to be put down by authority, as it had been years before in Scotland, where it had given rise to the suggestive proverb, "All is fair at the ball of Scone." The other class of hostile ball-games differs from this in the ball having not to be brought to one's own home, but sent to the goal of the other side. In the Greek *epikoinos*, or common-ball, the ball was put on the middle line, and each party tried to seize it and throw it over the adversary's goal-line. This game also lasted on into modern Europe, and our proper English name for it is *hurling*, while *football* also is a variety of it, the great Roman blown leather ball (*follis*) being used instead of the small hand-ball, and kicked instead of thrown. Now, as hurling was an ordinary classical game, the ancients need only have taken a stick to drive the ball instead of using hands or feet, and would thus have arrived at *hockey*. But Corydon never seems to have thought of borrowing Phillis's crook for the purpose it would have so exactly suited. No mention of games like hockey appears in the ancient world, and the course of invention which brought them into the modern world is at once unexpected and instructive.

The game known to us as *polo* has been traced by Sir W. Ouseley, in Persia, far back in the Sassanian dynasty, and was at any rate in vogue there before the eighth century. It was played with the long-handled mallet called *chugán*, which Persian word came to signify also the game played with it. This is the instrument referred to in the "Thousand and One Nights," and among various earlier passages where it occurs is the legend told by the Persian historian of Darius insulting Alexander by sending him a ball and mallet (*gũ ve chugán*) as a hint that he was a boy more fit to play polo than to go to war. When this tale finds its way to Scotland, in the romance of King Alisaunde, these unknown instruments are replaced by a whipping-top, and Shakespeare has the story in the English guise of a newer period in the scene in "Henry V.": "What treasure, uncle?"—"Tennis-balls, my

liege." By the ninth century the game of *chugán* had established itself in the Eastern Empire, where its name appears in the barbarous Greek form τζυκανίζειν. In the Byzantine descriptions, however, we find not the original mallet, but a long staff ending in a broad bend filled in with a network of gut-strings. Thus there appear in the East, as belonging to the great sport of ball-play on horseback, the first shapes of two implements which remodeled the whole play-life of mediæval and modern Europe, the chugán being the ancestor of the mallets used in pall-mall and croquet, and of an endless variety of other playing clubs and bats, while the bent staff with its network was the primitive racket. The fine old Persian drawing of a match at chugán, which is copied by Ouseley in his "Travels in the East," justifies his opinion that the horseback game is the original. We should not talk of polo as being "hockey on horseback," but rather regard hockey as dismounted polo, and class with it pall-mall, golf, and many another bat-and-ball game. Indeed, when one comes to think of it, one sees that no stick being necessary for the old foot-game of hurling, none was used, but, as soon as the Persian horsemen wanted to play ball on horseback, a proper instrument had to be invented. This came to be used in the foot-game also, so that the Orientals are familiar both with the mounted and dismounted kinds. The horseback game seems hardly to have taken hold in Europe till our own day, when the English brought it down from Munniepoor, and it has now under the name of *polo* become a world-wide sport again. But the foot-game made it way early into Europe, as appears from a curious passage in Joinville's "Life of St. Louis," written at the end of the thirteenth century. Having seen the game on his crusade, and read about it in the Byzantine historians, he argues that the Greeks must have borrowed their *tzycanisterium* from the French, for it is, he says, a game played in Languedoc by driving a boxwood ball with a long mallet, and called there *chicane*. The modern reader has to turn this neat and patriotic argument upside down, the French *chicane* being only a corruption of the Persian *chugán;* so that what Joinville actually proves is, that before his time the Eastern game had traveled into France, bringing with it its Eastern name. Already, in his day, from the ball-game with its shifts and dodges, the term *chicane* had come to be applied by metaphor to the shuffles of lawyers to embarrass the other side, and thence to intrigue and trickery in general. English has borrowed *chicane* in the sense of trickery, without knowing it as the name of a game. Metaphors taken from sports may thus outlast their first sense, as when again people say, "Don't *bandy* words with me," without an idea that they are using another metaphor taken from the game of hockey, which was called *bandy* from the curved stick or club it was played with.

In France, the name of *crosse*, meaning a crutch, or bishop's crosier, was used for the mallet, and thence the game of hockey has its

ordinary French name, *jeu de la crosse*. In Spanish, the game has long been known as *chueca*. The Spaniards taught it to the natives of South America, who took kindly to it, not as mere boys' play, but as a manly sport. It is curious to read accounts by modern European travelers, who seem not to recognize their own playground game when transplanted among the Araucanians of Chili, even though it shows its Spanish origin by the name of *chueca*. Seeing this, one asks whence did the North American Indians get their famous ball-play, known from California right across the Indian country? It is to all intents the European *chueca*, *crosse*, or *hockey*, the deerskin ball being thrown up in the middle, each of the two contending parties striving to throw or drive it through the adversaries' goal. The Iroquois say that in old times their forefathers played with curved clubs and a wooden ball, before the racket was introduced, with which to strike, carry, or throw the leather ball. Of all the describers of this fine game, Catlin has best depicted its scenes with pen and pencil, from its beginning with the night ball-play dance, where the players crowded round their goals, held up and clashed their rackets, and the women danced in lines between, and the old men smoked to the Great Spirit and led the chant for his favor in the contest. The painter would never miss a ball-play, but sit from morning till sundown on his pony, studying the forms of the young athletes in their "almost superhuman" struggles for the ball, till at last one side made the agreed number of goals, and divided with yells of triumph the fur robes and tin kettles and miscellaneous property staked on the match. Now, as to the introduction of the game into North America, the Jesuit missionaries in New France, as early as 1636, mention it by their own French name of *jeu de crosse*, at which Indian villages contended "à qui crossera le mieux." The Spaniards, however, had been above a century in America, and might have brought it in, which is a readier explanation than the other possible alternative that it made its way across from southeast Asia.

When the middle ages set in, the European mind at last became awake to the varied pleasure to be got out of hitting a ball with a bat. The games now developed need not be here spoken of at length proportioned to their great place in modern life, as the changes which gave rise to them are so comparatively modern and well known. The Persian apparatus kept close to its original form in the game of *pall-mall*, that is, "ball-mallet," into which game was introduced the arch or ring to drive the ball through, whereby enough incident was given to knocking it about to make the sport fit for a few players, or even a single pair. An account of pall-mall and its modern revival in *croquet* will be found in Dr. Prior's little book. Playing the ball into holes serves much the same purpose as sending it through rings, and thus came in the particular kind of bandy called *golf*, from the clubs used to drive the ball. The *stool-ball*, so popular in mediæval merrymak-

ings, was played with a stool, which one protected by striking away with his hands the ball which another bowled at it; the in-player was out if the stool was hit, or he might be caught out, so that here is evidently part of the origin of cricket, in which the present stumps seem to represent the stool. In *club-ball* a ball was bowled and hit with a club; and a game called *cat-and-dog* was played in Scotland two centuries ago, where players protected not wickets but holes from the wooden cat pitched at them, getting runs when they hit it. We have here the simple elements from which the complex modern cricket was developed. Lastly, among the obscure accounts of ancient ball-play, it is not easy to make out that the ball was ever sent against an opposite wall for the other player to take it at the bound and return it. Such a game, particularly suited to soldiers shut up in castle-yards, became popular about the fourteenth century under the name of *pila palmaria*, or *jeu de paulme*, which name indicates its original mode of striking with the palm of the hand, as in *fives*. It was an improvement to protect the hand with a glove, such as may still be seen in the ball-play of Basque cities, as at Bayonne. Sometimes a battledoor faced with parchment was used, as witness the story of the man who declared he had played with a battledoor that had on it fragments of the lost decades of Livy. But it was the racket that made possible the "cutting" and "boasting" of the mediæval tennis-court, with its elaborate scoring by "chases." No doubt it was the real courtyard of the château, with its penthouses, galleries, and grated windows, that furnished the tennis-court with the models for its quaintly artificial grilles and lunes so eruditely discussed in Mr. Julian Marshall's "Annals of Tennis." A few enthusiastic amateurs still delight in the noble and costly game, but the many have reason to be grateful for lawn-tennis out of doors, though it be but a mild version of the great game, to which it stands as hockey to polo or as draughts to chess.

Turning now to the principal groups of sedentary games, I may refer to the evidence I have brought forward elsewhere,* that the use of lots or dice for gambling arose out of an earlier serious use of such instruments for magical divination. The two conceptions, indeed, pass into one another. The magician draws lots to learn the future, and the gambler to decide the future, so that the difference between them is that between "will" and "shall." But the two-faced lot that can only fall head or tail can only give a simple yes or no, which is often too simple for either the diviner or the gambler. So we find African negroes divining with a number of cowries thrown together to see how many fall up and how many down; and this, too, is the Chinese method of solemn lot-casting in the temple, when the falling of the spoon-like wooden lots, so many up and so many down, furnishes an intricate result which is to be interpreted by means of the

* "Primitive Culture," chap. iii.

book of mystic diagrams. When this combination of a number of two-faced lots is used by gamblers, this perhaps represents the earlier stage of gaming, which may have led up to the invention of dice, in which the purpose of variety is so much more neatly and easily attained. The first appearance of dice lies beyond the range of history, for, though they have not been traced in the early periods in Egypt, there is in the Rig-Veda the hymn which portrays the ancient Aryan gambler stirred to frenzy by the fall of the dice. It is not clear even which came first of the various objects that have served as dice.

In the classic world girls used the astragali or hucklebones as playthings, tossing them up and catching them on the back of the hand; and to this day we may see groups of girls in England at this ancient game, reminding us of the picture by Alexander of Athens, in the Naples Museum, of the five goddesses at play. It was also noticed that these bones fall in four ways, with the flat, concave, convex, or sinuous side up, so that they form natural dice, and as such they have been from ancient times gambled with accordingly. In India Nature provides certain five-sided nuts that answer the purpose of dice. Of course, when the sides are alike, they must be marked or numbered, as with the four-sided stick-dice of India, and that which tends to supersede all others, the six-sided *kubos*, which gave the Greek geometers the name for the *cube*. Since the old Aryan period many a broken gamester has cursed the hazard of the die. We moderns are apt to look down with mere contempt at his folly. But we judge the ancient gamester too harshly if we forget that his passion is mixed with those thoughts of luck or fortune or superhuman intervention which form the very mental atmosphere of the soothsayer and the oracle-prophet. With devout prayer and sacrifice he would propitiate the deity who should give him winning throws; nor, indeed, in our own day have such hopes and such appeals ceased among the uneducated. To the educated it is the mathematical theory of probabilities that has shown the folly of the gamester's staking his fortune on his powers of divination. But it must be borne in mind that this theory itself was, so to speak, shaken out of the dice-box. When the gambling Chevalier de Méré put the question to Pascal in how many throws he ought to get double-sixes, and Pascal solving the problem started the mathematical calculation of chances, this laid the foundation of the scientific system of statistics which more and more regulates the arrangements of society. Thus accurate method was applied to the insurance-table, which enables a man to hedge against his ugliest risks, to eliminate his chances of fire and death by betting that he shall have a new roof over his head and a provision for his widow. Of all the wonderful turns of the human mind in the course of culture, scarce any is more striking than this history of lots and dice. Who, in the middle ages, could have guessed what would be its next outcome—that magic sunk

into sport should rise again as science, and man's failure to divine the future should lead him to success in controlling it?

Already in the ancient world there appear mentions of games where the throws of lots or dice, perhaps at first merely scored with counters on a board, give the excitement of chance to a game which is partly a draught-game, the player being allowed to judge with which pieces he will move his allotted number. In England this group of games is represented by *backgammon*. When Greek writers mention dice-playing, they no doubt often mean some game of this class, for at mere hazard the Persian queen-mother could not have played her game carefully, as Plutarch says she did, nor would there have been any sense in his remark that in life, as in dicing, one must not only get good throws, but know how to use them. The Roman game of the twelve lines (*duodecim scripta*) so nearly corresponded with our trictrac or backgammon, that M. Becq de Fouquières, in his "Jeux des Anciens," works out on the ordinary backgammon-board the problem of the Emperor Zeno that has vexed the soul of many a critic. All these games, however, are played with dice, and as there exist other games of like principle where lots are thrown instead of dice, it may perhaps be inferred that such ruder and clumsier lot-backgammon was the earlier, and dice-backgammon a later improvement upon it. Of course, things may have happened the opposite way. Lot-backgammon is still played in the East in more than one form. The Arabic-speaking peoples call it *tab*, or game, and play it with an oblong board or rows of holes in the ground, with bits of brick and stone for draughts of the two colors, and for lots four palm-stick slips with a black and white side. In this low variety of lot-backgammon, the object is not to get one's own men home, but to take all the adversary's. The best representative of this group of games is the Hindoo *pachisi*, which belongs to a series ancient in India. It is played on a cross-shaped board or embroidered cloth, up and down the arms of which the pieces move and take, in somewhat the manner of backgammon, till they get back to the central home. The men move by the throws of a number of cowries, of which the better throws not only score high, but entitle the player to a new throw, which corresponds to our rule of doubles giving a double move at backgammon. The game of pachisi has great vogue in Asia, extending into the far East, where it is played with flat tamarind-seeds as lots. It even appears to have found its way still farther eastward, into America, forming a link in the chain of evidence of an Asiatic element in the civilization of the Aztecs.* For the early Spanish-American writers describe, as played at the court of Montezuma, a game called *patolli*, played after the manner of their European tables or backgammon, but on a mat with a diagram like a + or Greek cross, full of squares on which the different-colored stones or pieces of the

* See the author's paper in the "Journal of the Anthropological Institute," November, 1878.

players were moved according to the throws of a number of marked beans. Without the board and pieces, the mere throwing hazards with the beans or lots, to bet on the winning throws, furnishes the North American tribes with their favorite means of gambling, the game of plum-stones, game of the bowl, etc.

It is a curious inquiry what led people to the by no means obvious idea of finding sport in placing stones or pieces on a diagram and moving them by rule. One hint as to how this may have come about is found in the men at backgammon acting as though they were "counters" counting up the throws. The word *abax*, or *abacus*, is used both for the reckoning-board with its counters and the play-board with its pieces, whence a plausible guess has been made that playing on the ruled board came from a sportive use of the serious counting instrument. The other hint is that board-games, from the rudest up to chess, are so generally of the nature of *Kriegspiel*, or war-game, the men marching on the field to unite their forces or capture their enemies, that this notion of mimic war may have been the very key to their invention. Still these guesses are far from sufficient, and the origin of board-games is still among the anthropologist's unanswered riddles. The simpler board-games of skill, that is, without lots or dice, and played by successive moves or draws of the pieces, may be classed accordingly as games of *draughts*, this term including a number of different games, ancient and modern.

The ancient Egyptians were eager draught-players; but though we have many pictures, and even the actual boards and men used, it is not clear exactly how any of their games were played. Ingenuity and good heavy erudition have been misspent by scholars in trying to reconstruct ancient games without the necessary data, and I shall not add here another guess as to the rules of the draughts with which Pénelope's suitors delighted their souls as they sat at the palace gates on the hides of the oxen they had slaughtered; nor will I discuss the various theories as to what the "sacred line" was in the Greek game of the "five lines," mentioned by Sophocles. It will be more to the purpose to point out that games worth keeping up hardly die out, so that among existing sports are probably represented, with more or less variation, the best games of the ancients. On looking into the mentions of the famous Greek draught-game of *plinthion*, or *polis*, it appears that the numerous pieces, or "dogs," half of them of one color and half of the other, were moved on the squares of the board, the game being for two of the same color to get one of the other color between them, and so take him. The attempt to reason out from this the exact rules of the classic game has not answered. But on looking, instead of arguing, I find that a game just fitting the description still actually exists. The donkey-boys of Cairo play it in the dust with "dogs," which are bits of stone and red brick, and the guides have scratched its *siga*, or diagram, on the top of the great pyramid. If it

was not there before, it would have come with Alexander to Alexandria, and has seemingly gone on unchanged since. There is an account of it in Lane's "Modern Egyptians," and any one interested in games will find it worth trying with draughts on a cardboard square. One kind of the Roman game of *latrunculi* was closely related to this, as appears from such passages as Ovid's "cum medius gemino calculus hoste perit," referring to the stone being taken between two enemies. The poet mentions, a few lines further on, the little table with its three stones, where the game is "continuasse suos," to get your men in a line, which is, of course, our own childish game of *tit-tat-to*. This case of the permanence of an ancient game was long ago recognized by Hyde in his treatise, "De Ludis Orientalibus." It is the simplest form of the group known to us as *mill*, *merelles*, *morris*, played by children all the way across from Shetland to Singapore. Among the varieties of draught-games played in the world, one of the most elaborate is the Chinese *wei-chi*, or game of circumvention, the honored pastime of the learned classes. Here one object is to take your enemy by surrounding him with four of your own men, so as to make what is called an "eye," which looks as though the game belonged historically to the same group as the simpler classic draughts, where the man is taken between two adversaries. In modern Europe the older games of this class have been superseded by one on a different principle. The history of what we now call *draughts* is disclosed by the French dictionary, which shows how the men used to be called *pions*, or pawns, till they reached the other side of the board, then becoming *dames*, or queens. Thus the modern game of draughts is recognized as being, in fact, a low variety of chess, in which the pieces are all pawns, turned into queens in chess-fashion when they gain the adversary's line. The earliest plain accounts of the game are in Spanish books of the middle ages, and the theory of its development through the mediæval chess problems will be found worked out by the best authority on chess, Dr. A. van der Linde, in his "Geschichte des Schachspiels."

The group of games represented by the Hindoo *tiger-and-cows*, our *fox-and-geese*, shows in a simple way the new situations that arise in board-games when the men are no longer all alike, but have different powers, or moves. Isidore of Seville (about A. D. 600) mentions, under the name of *latrunculi*, a game played with pieces of which some were common soldiers (*ordinarii*), marching step by step, while others were wanderers (*vagi*). It seems clear that the notions of a kriegspiel, or war-game, and of pieces with different powers moving on the checker-board, were familiar in the civilized world at the time when, in the eighth century or earlier, some inventive Hindoo may have given them a more perfect organization by setting on the board two whole opposing armies, each complete in the four forces, foot, horse, elephants, and chariots, from which an Indian army is called in Sanskrit *chaturanga*,

or "four-bodied." The game thus devised was itself called *chaturanga*, for when it passed into Persia it carried with it its Indian name in the form *shatranj*, still retained there, though lost by other nations who received the game from Persia, and named it from the Persian name of the principal piece, the *shah*, or king, whence *schach*, *eschecs*, *chess*. According to this simple theory, which seems to have the best evidence, chess is a late and high development arising out of the ancient draught-games. But there is another theory maintained by Professor Duncan Forbes in his "History of Chess," and prominent in one at least of our chess handbooks, which practically amounts to saying that chess is derived from backgammon. It is argued that the original game was the Indian fourfold-chess, played with four half-sets of men, black, red, green, and yellow, ranged on the four sides of the board, the moves of the pieces being regulated by the throws of dice; that in course of time the dice were given up, and each two allied half-sets of men coalesced into one whole set, one of the two kings sinking to the position of minister, or queen. Now, this fourfold Indian dice-chess is undoubtedly a real game, but the mentions of it are modern, whereas history records the spread of chess proper over the East as early as the tenth century. In the most advanced Indian form of *pachisi*, called *chupur*, there are not only the four sets of different-colored men, but the very same stick-dice that are used in the dice-chess, which looks as though this latter game, far from being the original form of chess, were an absurd modern hybrid resulting from the attempt to play backgammon with chess-men. This is Dr. van der Linde's opinion, readers of whose book will find it supported by more technical points, while they will be amused with the author's zeal in belaboring his adversary Forbes, which reminds one of the legends of mediæval chess-players, where the match naturally concludes by one banging the other about the head with the board. It is needless to describe here the well-known points of difference between the Indo-Persian and the modern European chess. On the whole, the Indian game has substantially held its own, while numberless attempts to develop it into philosophers' chess, military tactics, etc., have been tried and failed, bringing, as they always do, too much instructive detail into the plan which in ancient India was shaped so judiciously between sport and science.

In this survey of games, I have confined myself to such as offered subjects for definite remark, the many not touched on including cards, of which the precise history is still obscure. Of the conclusions brought forward, most are no doubt imperfect, and some may be wrong, but it seemed best to bring them forward for the purpose of giving the subject publicity, with a view to inducing travelers and others to draw up minutely accurate accounts of all undescribed games they notice. In Cook's "Third Voyage" it is mentioned that the Sandwich Islanders played a game like draughts with black and white pebbles on a board of fourteen by seventeen squares. Had the explorers spent an

hour in learning it, we should perhaps have known whether it was the Chinese or the Malay game, or what it was; and this might have been the very clew, lost to native memory, to the connection of the Polynesians with a higher Asiatic culture in ages before a European ship had come within their coral reefs.

It remains to call attention to a point which this research into the development of games brings strongly into view. In the study of civilization, as of so many other branches of natural history, a theory of gradual evolution proves itself a trustworthy guide. But it will not do to assume that culture must always come on by regular, unvarying progress. That, on the contrary, the lines of change may be extremely circuitous, the history of games affords instructive proofs. Looking over a playground wall at a game of hockey, one might easily fancy the simple line of improvement to have been that the modern schoolboy took to using a curved stick to drive the ball with, instead of hurling it with his hands as he would have done if he had been a young Athenian of B. C. 500. But now it appears that the line of progress was by no means so simple and straight, if we have to go round by Persia, and bring in the game of polo as an intermediate stage. If, comparing Greek draughts and English draughts, we were to jump to the conclusion that the one was simply a further development of the other, this would be wrong, for the real course appears to have been that some old draught-game rose into chess, and then again a lowered form of chess came down to become a new game of draughts. We may depend upon it that the great world-game of evolution is not played only by pawns moving straight on, one square before another, but that long-stretching moves of pieces in all directions bring on new situations, not readily foreseen by minds that find it hard to see six moves ahead upon a chess-board.—*Fortnightly Review.*

WHALES AND THEIR NEIGHBORS.

By Dr. ANDREW WILSON.

THE medical student, who, in answer to an examiner anxious to ascertain the exact amount of the lad's knowledge concerning fishes, replied that "he knew them all from the limpet to the whale," must indeed be credited with a larger share of candor than of zoölogical science. The limpet is a shell "fish" by courtesy at the best, but the whale, public opinion notwithstanding, is not a fish in any sense of the term. The most that can be said of the whale in this respect is that it is fish-like; and, admitting that appearances in zoölogical study are as deceptive as in ordinary existence, it behooves us to be cautious in accepting outward resemblances as indicative of real and

veritable affinity. A popular lesson in natural history, then, teaches us that a whale is a quadruped—that is, apart from the mere etymology of the word, it belongs to the quadruped class. It possesses but two legs, or rather "arms," it is true, and these members do not resemble limbs. But it is a quadruped notwithstanding its deficiencies in this respect; and it agrees in all the characters which are found to distinguish the class to which man himself belongs, that of the Mammalia. These characters it may be advantageous very briefly to detail, by way of preliminary to the general study of whales and their nearest relations. Thus, firstly, they are warm-blooded animals, a statement which must be taken as meaning that their blood is of a temperature considerably higher than that of the medium in which they live. The fish, on the other hand, is a cold-blooded creature. Its temperature is only slightly higher than that of the surrounding water, and in this respect it agrees with all invertebrate animals and with the frogs and reptiles of its own sub-kingdom. Next in order may be noticed the agreement of the whale with the quadruped in the matter of body-covering. The covering of the latter consists of hairs. Although the body of the whale can not be described, by any stretch of the imagination, as having hair, the presence of a few bristles around the mouth-extremity sufficiently indicates the nature of its outer garment; while, before birth, the body-covering in some whales is tolerably plentiful, but is soon shed, leaving the hide thick, shining, and hairless. The microscopist might inform us that the blood of the whale presents the same characters as that of other mammals, and possesses red corpuscles or colored bodies, which, unlike those of the fish, reptile, and bird, have no central particle or "nucleus." And while the heart of the fish is a comparatively simple engine of propulsion, consisting of two contractile chambers or cavities, the whale's heart will be found like that of man and other quadrupeds in all essential details of its structure. It is thus a four-chambered organ doing double duty, in that it sends blood not only through the system, but also to the lungs for purification.

The mention of lungs as the breathing organs of whales at once introduces us to a new field of inquiry concerning the habits and life of the aquatic monsters. A popular notion exists that of necessity a water-living animal must be a *water-breather*. The idea of fish existence and of the manner in which fishes breathe evidently reigns paramount in the present case. That an animal may be completely aquatic in its habits, and yet breathe air directly from the atmosphere, and after a like procedure to that witnessed in human respiration, is a notable fact. A water-newt, despite its aquatic habits, ascends periodically to the surface of the water to breathe; and seals, walruses, and whales agree in that they are truly lung-breathers, and possess gills at no period of their existence. True, a gill differs from a lung only in that it is capable of exposing the blood circulating through it to the

air which is entangled or mechanically suspended in the water. Atmospheric air containing the vitalizing oxygen for the renewal and purification of the blood is the great desideratum on the part of all animals, high and low alike. And the gill and lung, therefore, differ simply in the manner and method in which the blood in each is brought in contact with the air, and not in the essential details of their work. The whales are known to "blow," and the act of "blowing" is simply the act of breathing—to be more particularly noticed hereafter. Thus, a whale or seal would be drowned as certainly as an ordinary quadruped would be asphyxiated, were its periodical access to the atmosphere prevented; and the curious fact may here be mentioned that there are also certain abnormal living fishes—notably the climbing perch and *ophiocephali* of India—which, to use the words of a writer, are as easily drowned as dogs when denied access to the air. There is little need to particularize any of the remaining characters which demonstrate the whale's relationship to mammals, and its difference in structural points from the fishes. The young whale is thus not merely born alive, but is nourished by means of the milk-secretion of the parent, and this last evidence of direct connection with higher animals might of itself be deemed a crucial test of the place and rank of the whales in the animal series.

But, granting that in the whales we meet with true quadrupeds, it may be well to indicate the chief points in which they differ from their mammalian brethren at large. It may be admitted, at the outset, that they present us with a very distinct modification of the quadruped type. Their adaptation to a water-life is so complete, in truth, that it has destroyed to a large extent the outward and visible signs of their relationship with mammals. The body is thoroughly fish-like and tapers toward the tail, where we meet with a tail-fin, which, however, is set right across the body, and not vertically as in the fishes. This latter difference, indeed, is a very prominent feature in whale-structure. The limbs, as already remarked, are represented by the two fore-limbs alone. No trace of hinder-extremities is to be perceived externally, and the anatomical investigation of the skeleton reveals at the best the merest rudiments of haunch-bones and of hind-limbs in certain whales, of which the well-known Greenland whale may be cited as an example. A distinct character of the whales has been found by naturalists of all periods in the "blowholes" or apertures through which the whale is popularly supposed to "spout." Thus we find on the upper surface of the head of a Greenland whale a couple of these "blowholes," or "spiracles," as they are also called. These apertures exist on the front of the snout in the sperm whales, while in the porpoises, dolphins, and their neighbors the blowhole is single, of crescentic shape, and placed on the top of the head. It requires but little exercise of anatomical skill to identify the "blowholes" of the whales with the nostrils of other animals; and it becomes an interest-

ing matter to trace the adaptation of the nostrils to the aquatic life and breathing habits of these animals.

There are natural history text-books still extant in which a very familiar error regarding the "blowing" of the whales is propagated—an error which, like many other delusions of popular kind, has become so fossilized, so to speak, that it is difficult to convince believers of its falsity. A manual of natural history, of no ancient date, lies before me as I write, and when I turn to the section which treats of the whales, I find an illustration of a Greenland whale, which is represented as lying high and dry on the beach, but which, despite its stranded state, appears in the act of vigorously puffing streams of water from the blowholes on the top of its head. To say the least of it, such an illustration is simply fictitious, and might safely be discarded as of purely inventive kind, were it only from the fact of its supposing a whale to be provided with some mysterious reservoir of water from which it could eject copious streams, even when removed from the sea. The common notion regarding the "blowing" of the whale appears to be that which credits the animal with inhaling large quantities of water into its mouth, presumably in the act of nutrition. This water was then said to escape into the nostrils and to be ejected therefrom in the act of blowing. The behavior of a whale in the open sea at first sight favors this apparently simple explanation. Careering along in the full exercise of its mighty powers, the huge body is seen to dive and to reappear some distance off at the surface, discharging from its nostrils a shower of water and spray. The observation is correct enough as it stands, but the interpretation of the phenomena is erroneous. Apart from the anatomical difficulties in the way of explaining how water from the mouth could escape in such large quantities, and so persistently into the nostrils, there is not merely an utter want of purpose in this view of the act of "spouting," but we have also to consider that this act would materially interfere with the breathing of the animal. Hence a more rational explanation of what is implied in the "blowing" of the whales rests on the simple assertion that the water and spray do not in reality proceed from the blowhole, but consist of water forced upward into the air by the expiratory effort of the animal. The whale begins the expiratory or "breathing-out" action of its lungs just before reaching the surface of the water, and the warm expired air therefore carries up with it the water lying above the head and blowholes of the ascending animal. That this view is correct is rendered highly probable, not merely by the observation of the breathing of young whales and porpoises kept in confinement, but also by the fact that the last portion of the "blow" consists of a white silvery spray or vapor, formed by the rapid condensation of the warm air from the lungs as it comes in contact with the colder atmosphere. The water received into the mouth escapes at the sides of the mouth, and does not enter the nostrils at all.

The furnishings of the mouth of the whales include sundry remarkable structures peculiar to a certain family circle of these animals. Such are the "whalebone"-plates, furnishing a substance familiarly spoken of by everybody, but exemplifying at the same time a kind of material regarding the origin of which a tacit ignorance, sanctioned by the stolid indifference of many years' standing, commonly prevails. Whalebone, or "baleen," is a commodity occurring in one group of these animals only, this group being that of the whalebone whales (*Balænidæ*), of which the Greenland or Right whale (*Balæna mysticetus*) is the most noteworthy example. From this whale the whalebone of commerce is derived; other and nearly related species—such as the Rorquals and Furrowed whales—possessing the whalebone-plates in a comparatively rudimentary state. The baleen occurs in the mouth of these whales, and is disposed in a curious fashion. It exists in the form of flat plates of triangular shape, each plate being fixed by its base in the palate. The inner side, or that next the center of the mouth, is strongly fringed by frayed-out whalebone fibers, the outer edge of each plate being straight. A double row of these triangular plates of baleen depends in the form of two great fringes from the palate of the whale; and it would appear that each baleen-plate is in reality a compound structure, being composed of several smaller plates closely united. The largest plates lie to the outer side of the series, and in a full-grown whale may measure from eight to fourteen feet in length, and as many as 250 or 300 plates may exist on each side of the palate.

The nature of these curious organs forms an appropriate subject of inquiry. It is exceedingly rare in nature to find an animal provided with organs or structures which have no affinity with organs in other and related animals. On the contrary, the principle of likeness or "homology" teaches us that the most unwonted and curious structures in animal existence are for the most part modifications of common organs, or at any rate of parts which are represented under varying forms and guises in other animals. By aid of such a principle we discover that the fore-limb of a horse, the wing of a bird, and the paddle of a whale are essentially similar in fundamental structure, and in turn agree in all necessary details with the arm of man. Through the deductions of this science of tracing likenesses and correspondences between the organs of different animals, the zoölogist has been taught that the "air-bladder" or "sound" of the fish is the forerunner of the lung of higher animals—an inference proved by the fact that in some fishes, such as the curious Lepidosirens or "mud-fishes" of Africa and South America, the air-bladder actually becomes lung-like, not merely in form but in function also. By means of this useful guide to the mysteries of animal structure, we note that the bony box in which the body of the tortoise or turtle is contained is formed by no new elements or parts, but consists chiefly of the greatly modified backbone and of the ribs

and scales of these animals. To what conclusion, then, does this same principle lead us respecting the nature of the baleen-plates in the mouth of the Greenland whale and its allies? To a sufficiently certain, but at the same time startling thought, is the reply of the comparative anatomist.

If we examine the structure of the human mouth, or that of animals allied to man, we find that cavity to be lined by a delicate layer named *epithelium*. This epithelium consists really of a modification of the upper layer of the skin, and we see this modification familiarly in the difference between the skin of the face and the layer which is infolded to form the covering of the lips and the lining membrane of the mouth. No tissue is more familiar to the student of physiology than epithelium, composed as it is of *epithelial cells* or microscopic elements, which in one form or another are found in almost every important tissue of the body. The epithelium is a delicate tissue, as usually seen in man and vertebrate animals; but in some instances it becomes hardened by the development of horny matter, and may then appear as a tissue of tolerably solid consistence. In the mouth of a cow or sheep, the epithelium of part of the upper jaw is found hardened and callous, and there forms a horny pad against which the front teeth of the lower jaw may bite in the act of mastication. It is exactly this epithelial layer, then, which becomes enormously developed in the whalebone whales to form the baleen-plates just described. That this is actually the case is ascertained by the development of the baleen-plates, as well as by their situation and relations to the gum and palate. And the recital becomes the more astonishing when we consider that, from cells of microscopic size in other animals, structures of enormous extent may be developed in the whales. The baleen-plates possess a highly important office. They constitute a kind of huge strainer or sieve, the possession of which enables the whale to obtain its food in a convenient fashion. Whether or not Biblical scholars and commentators agree in regarding the "great fish" which wrought calamity to the prophet Jonah as a special creation, and as an entirely different animal from the whale of to-day, the plain fact remains that a whale has a gullet of relatively small size when compared with the bulk of the animal. Fortunately, however, the faith of rational mankind is not pinned to literal interpretation of the untoward incident chronicled in Jonah, and, whale or no whale, it is curious to learn that the largest of animals may in a manner be said to feed on some of the most diminutive of its fellows. In the far north, and in the surface-waters of the Arctic seas, myriads of minute organisms, closely allied to our whelks, and like mollusks, are found. Such are the "Sea-butterflies," or *Pteropoda* of the naturalist: little delicate creatures which paddle their way through the yielding waters by aid of the wing-like appendages springing from the sides of the head and neck. These organisms are drawn into the mouth of the Greenland whale in veritable shoals, and as the

literal flood of waters streams out of the sides of the mouth, the "sea-butterflies" are strained off therefrom, the savory morsels being retained by the fringed edges of the baleen-plates, and thereafter duly swallowed as food.

An interesting speculation yet remains, however, regarding the origin and first development of these peculiar whalebone-structures. Advocates of the doctrine which assumes that animal forms and their belongings arise by gradual modifications of preëxistent animals may be reasonably asked to explain the origin of the baleen-plates of the whales. Let us briefly hear what Mr. Darwin, as the spokesman of the party, has to say in reply to such an inquiry. Quoting a remark of an opponent regarding the whalebone, Mr. Darwin says, if the baleen "'had once attained such a size and development as to be at all useful, then its preservation and augmentation within serviceable limits would be promoted by natural selection alone. But how to obtain the beginning of such useful development?' In answer," continues Mr. Darwin (in his own words), "it may be asked, why should not the early progenitors of the whales with baleen have possessed a mouth constructed something like the lamellated beak of a duck. Ducks, like whales, subsist by sifting the mud and water; and the family (of ducks) has sometimes been called *Criblatores*, or sifters." Mr. Darwin's reference to the duck's bill is peculiarly happy. The edges of the beak in these birds are fringed with a beautiful series of horny plates named *lamellæ*, which serve as a straining apparatus as the birds grope for their food amid the mud of ponds and rivers. These plates are richly supplied with nervous filaments, and doubtless also some as organs of touch. Mr. Darwin is careful to add that he hopes he may not "be misconstrued into saying that the progenitors of whales did actually possess mouths lamellated like the beak of a duck. I only wish to show," he continues, "that this is not incredible, and that the immense plates of baleen in the Greenland whale might have been developed from such lamellæ by finely graduated steps, *each of service to its possessor.*"

In these last words, which we have italicized, lies the strength of Mr. Darwin's hypothesis. Nature will preserve and develop useful structures alone, and will leave the useless and unneeded to perish and decay. This, indeed, is the keynote of natural selection. Mr. Darwin next proceeds to examine in detail the plates and lamellæ in the bill of a shoveler duck. He describes the horny plates, one hundred and eighty-eight in number, which "arise from the palate, and are attached by flexible membrane to the sides of the mandible." He further notes that these plates "in several respects resemble the plates of baleen in the mouth of a whale." If the head of a shoveler duck were made as long as the head of a species of whale in which the baleen-plates are only nine inches long, the duck's lamellæ would be six inches in length. The head of the shoveler is about one eighteenth

of the length of the head of such a whale, so that the difference in size between the duck's lamellæ and the imperfect baleen-plates of this whale is not markedly disproportionate, after all. After the examination of the beaks of various species of swimming-birds, Mr. Darwin arrives at the conclusion that "a member of the duck family with a beak constructed like that of the common goose, and adapted solely for grazing, or even a member with a beak having less well-developed lamellæ, might be converted by small changes into a species like the Egyptian goose (which partly grazes and partly sifts mud)—this into one like the common duck—and, lastly, into one like the shoveler, provided with a beak almost exclusively adapted for sifting the water; for this bird could hardly use any part of its beak, except the hooked tip for seizing or tearing solid food. The beak of a goose, as I may add," says Mr. Darwin, "might also be converted by small changes into one provided with prominent recurved teeth, like those of the Merganser (a member of the same family), serving for the widely different purpose of securing live fish."

Mr. Darwin next endeavors to apply the moral of this interesting sketch of probable modification of the bills of ducks to the case of the whales. If the stages of modification in these animals are hypothetically so clear, may not the case of the whalebone-bearing whales be susceptible of like explanation? A certain whale (*Hyperoödon*) belonging to a small group known popularly as the "beaked whales," from the possession of a prominent beak or snout, has no true teeth, but bears rough, unequal knobs of horny nature in its palate. Here, therefore, is a beginning for the work of selection and development. Granted that these horny processes were useful to the animal in the prehension and tearing of food, then their subsequent development into more efficient organs is a warrantable inference if the order of living nature teaches us aright. From rudimentary knobs, a further stage of development would lead to an increase in which they may have attained the size of the lamellæ of an Egyptian goose, which, as already remarked, are adapted both for sifting mud and for seizing food. A stage beyond, and we reach the shoveler's condition, "in which the lamellæ would be two thirds of the length of the plates of baleen," in a species of whalebone whale (*Balænoptera*) possessing a slight development of these organs. And from this point, the further gradations leading onward to the enormous developments seen in the Greenland whale itself, are easily enough traced. Hypothetically, therefore, the path of development is clear enough. Even if it be remarked that the matter is entirely one of theory, not likely to be ever partly verified, far less proved at all, we may retort that any other explanation of the development of the organs of living beings, and of living beings themselves, must also be theoretical in its nature and as insusceptible of direct proof as are Mr. Darwin's ideas. But the thoughtful mind must select a side, and choose between probabilities;

and it is not too much to say that toward the side of the idea which advocates gradual modification and selection as the rule of life and nature, every unbiased student of natural science will by sheer force of circumstances be led to turn.

The whalebone whales have no teeth, although the sperm whale possesses teeth in the lower jaw; but thereby—that is, as regards the teeth of whales at large—hangs a tale of some importance, and to which our attention may be briefly directed. Among the paradoxes of living nature, no circumstances present more curious features than those relating to the so-called "rudimentary organs" of animals and plants; the subject of these organs, and the lessons they are well calculated to teach, having been recently treated at some length in these pages. Now, the whales furnish several notable examples of the anomalies which apparently beset the pathways of development in animals. The adult whalebone whale is toothless, as has just been remarked; and this fact becomes more than usually interesting when taken in connection with another, namely, that the young whale before birth possesses teeth, which are shed or absorbed, and in consequence disappear before it is born. These teeth never "cut the gum," and the upper jaw of the sperm whale presents us with a like phenomenon for consideration. Nor are the whales peculiar in this respect. The upper jaw of ruminant animals has no front teeth—as may be seen by looking at the mouth of a cow or sheep—yet the calf may possess rudimentary teeth in this situation, these teeth also disappearing before birth. Now, what meaning, it may be asked, are we to attach to such phases of development? Will any considerations regarding the necessity for preserving the "symmetry," or "type," of the animal form aid us here; or will the old and overstrained argument from design enable us to comprehend why nature should provide a whale or a calf with teeth for which there is no conceivable use? The only satisfying explanation which may be given of such anomalies may be couched in Darwin's own words. The embryonic teeth of the whales have a reference "to a former state of things." They have been retained by the power of inheritance. They are the ignoble remnants and descendants of teeth which once were powerful enough, and of organs with which the mighty tenants of the seas and oceans of the past may have waged war on their neighbors. Again, the laws and ideas of development stand out in bold relief as supplying the key to the enigma. Adopt the theory that "things are now just as they always were," and what can we say of rudimentary teeth, save that Nature is a blunderer at best, and that she exhibits a lavish waste of power in supplying animals with useless structures? But choose the hypothesis of development, and we may see in the embryo-teeth the representatives of teeth which in the ancestors of our whales served all the purposes of such organs. Admit that, through disuse, they have become abortive and useless; and we may then, with some de-

gree of satisfaction, explain their true nature. To use Darwin's simile, such rudiments are like letters in a word which have become obsolete in pronunciation, but which are retained in the spelling, and serve as a clew to the derivation of the word.

In the course of these remarks allusion has been made to more than one species of whale, and it may, therefore, form a study of some interest if we endeavor, shortly, to gain an idea of the general relationship and degrees of affinity of the various members of this curious family-circle. The whale order includes several of the divisions to which the zoölogist applies the name of "families," indicating, by this latter term, a close affinity in form, structure, and habits between the members of each group. First in importance among these families comes that of the whalebone whales (*Balænidæ*). Here we find family characters in a head disproportionately large when compared with the body as a whole, while the muzzle is sloping, and of rounded conformation. Teeth are absent, as we have seen; whalebone-plates fringe the palate; and the "blowhole" is single, and exists on the top of the head. Such are the family characters in which the Greenland or Right whale and the still larger Rorqual participate along with the "finner" whales and "humpbacked" whales. There is no back fin in the Greenland whale, but the Rorquals and their neighbors possess this appendage. It need hardly be said that, commercially, the former animal is of most importance; while the Rorquals are famed as the largest of the whales. Specimens of the Rorqual have been captured exceeding a hundred feet in length. One specimen, measuring ninety-five feet in length, weighed 245 tons. Next in importance to the Greenland whale and its relatives may be mentioned the family *Physeteridæ*, of which the sperm whale is the representative form. Here, the head reaches literally enormous proportions, and may make up fully one third of the body. A blunt, square muzzle; a lower jaw armed with teeth; an absence of baleen-plates, and a front blowhole —such are the characters of the sperm whale, which gives sperm-oil to the merchant, and spermaceti and ambergris to the man of drugs. A whole host of "small fry" present themselves as near relations of the whales, in the shape of the dolphins, porpoises, grampus, "bottle-noses," and other animals, including the famous narwhal, or sea-unicorn, possessing the longest tooth in the world in the shape of a spiral ivory pole, of some eight or ten feet in length. Here also the *Beluga catodon*, or "white whale," finds a zoölogical home, this latter form being the species of which more than one specimen has been recently exhibited in London. The beluga, being a member of the dolphin family, is a "whale" by courtesy only. Like the other members of this group, its blowhole is single and crescentic in shape, and both jaws are well provided with teeth. But the beluga, unlike the dolphins and porpoises, has no back fin, and its muzzle is blunt. This animal, however, is still certainly "very like a whale" in its general

shape and aspect. Its creamy, white skin is certainly a peculiar feature; but the broad, horizontal tail-fin is well exemplified in this northern stranger, while the breathing habits of its group may also be studied superficially but satisfactorily on the specimen in question. The beluga inhabits the North American coast, at the mouths of the rivers on the Labrador and Hudson's Bay coast, while it is known to penetrate even to the Arctic regions. These whales are plentiful in the Gulf of St. Lawrence in spring and summer, and appear to migrate to the west coast of Greenland in October and November. The Esquimaux regard the beluga as their special prize, and contrive, with the aptitude for design which the necessities of savage existence teach, to utilize wellnigh every portion of its frame, even to the manufacture of a kind of animal-glass from its dried and transparent internal membranes.

But little space remains in which to treat of certain near relations and somewhat interesting allies of the whales. Such are the *Manatees*, or "sea-cows," and the Dugongs, collectively named *Sirenia*, in the category of zoölogists. The origin of this latter name is attended with some degree of interest. It has been bestowed on these animals from their habit of assuming an upright or semi-erect posture in the water; their appearance in this position, and especially when viewed from a distance by the imaginative nautical mind, having doubtless laid a foundation, in fact, for the tales of "sirens" and "mermaids" anxious to lure sailors to destruction by their amatory numbers. Any one who has watched the countenance of a seal from a short distance must have been struck with the close resemblance to the human face which the countenance of these animals presents. Such a likeness is seen even to a greater degree in the sea-cows, which also possess the habit of folding their "flippers," or swimming-paddles, across their chests, and, it is said, of holding the young to the breast in the act of nutrition by aid of the paddle-like fore-limbs. If I mistake not, Captain Sowerby mentions, in an account of his voyages, that the surgeon of the ship on one occasion came to him in a state of excitement to announce that he had seen a man swimming in the water close at hand; the supposed human being proving to be a manatee, which had been, doubtless, merely exercising a natural curiosity regarding the ship and its tenants.

These animals are near relatives of the whales, but differ from them, not merely in habits, but in bodily structure and conformation. They live an estuarine existence, rarely venturing out to sea. The manatees occur in the shallow waters and at the mouths of the great rivers of the Atlantic coasts of America and Africa. The dugongs inhabit the shores of the Indian Ocean, and are common on certain parts of the Australian coasts. There are only two living genera—the manatees and dugongs—of these animals; a third, the *Rhytina Stelleri*, having, like the famous Dodo, become extinct through its

wholesale slaughter by man, in 1768, just twenty-seven years after it was first discovered by the voyager Behring on a small island lying off the Kamtchatkan coast. The Rhytina was a great unwieldy animal of some twenty-seven feet in length, and about twenty feet in circumference. It fell a ready prey to Behring and his crew, who were located on the island for several months; the work of extermination being duly completed by subsequent voyagers who visited the island. The manatees are no strangers to London, since in 1875 one of these animals was to be seen disporting itself in the seal-tank in the gardens of the Zoölogical Society at Regent's Park. This specimen, a female of immature age, was brought from the Demerara coast, and was the first living specimen which had been brought to England, although attempts had been made in 1866 to procure these animals for the gardens at Regent's Park, one specimen, indeed, dying just before reaching Southampton. A member of the Manatee group, obtained from Trinidad, was recently exhibited in London, and the public, interested in the curious in zoölogy, were thus enabled to interview a living member of the Siren group, while comparative anatomists, in their turn, have been afforded a rich treat from the fate which awaits rare and common specimens having, as we write, overtaken the illustrious visitor in question.

The manatees and dugongs possess bodies which, as regards their shape, may be described each as a great barrel "long drawn out." No hinder limbs are developed, this latter peculiarity distinguishing them from the seals, and relating them to the whales. The hide is very tough, sparsely covered with hair, and most nearly resembles that of the hippopotamus. The "flippers," or paddle-like limbs, are placed far forward on the body, and on the edge of the paddle rudimentary nails are developed; while concealed beneath the skin of the paddle we find the complete skeleton of an arm or fore-limb. The tail is broad, horizontally flattened, like that of the whales, and forms an effective propeller. These animals are vegetable feeders, the Zoölogical Society's specimen having exhibited a strong partiality for lettuce and vegetable-marrow. In a state of nature the sea-cows crop the marine vegetation which fringes their native shores. The remaining outward features of interest in these creatures may be summed up by saying that no back fins are developed; that the eyes are very small and inconspicuous; and that, although the anterior nostrils are never used as "blowholes," they can be closed at will like the nostrils of the seals—a faculty of needful kind in aquatic animals. To the technical anatomist, the sea-cows present strong points of resemblance to some of the hoofed quadrupeds. The anatomical examination of these animals has shown that their peculiarities are not limited to their outward appearance and habits. It is not generally known, for example, that the neck of the vast majority of mammals consists of seven vertebræ or segments of the spine. Man thus possesses this number in

common with the giraffe, the elongation of whose neck is produced not by introduction of new vertebræ, but by the great development of the normal number, seven. The manatees, however, present a very remarkable exception to this most general of rules, in that they possess only six vertebræ in their necks. The only other exceptions to the rule of seven, as the normal number of neck-vertebræ in quadrupeds, are found in one species of sloth which has six vertebræ like the manatee, and in another kind of sloth which possesses nine. Then, also, the manatees possess a heart of very curious conformation, its apex or tip being widely cleft or divided—a feature much more plainly marked in these animals than in the elephants and seals, whose hearts, anatomically speaking, are also divided. The manatees possess well-developed molars or grinding teeth, but have no front teeth in the adult state. Like the whalebone whale, however, the young manatee has front teeth, these again disappearing before birth, and presenting us once more with examples of rudimentary organs which possess a reference "to a former state of things."

What evidence is at hand respecting the remote ancestors of the whales and their neighbors? is a question which may form a fitting conclusion to these brief details of the family history of the group. The geological evidence shows us that the whales are comparatively "recent" forms, speaking geologically, and dealing—notwithstanding the word "recent"—with very remote and immense periods of time. Among the oldest fossil whales we find one form in particular (*Zeuglodon*) which had teeth of larger kind than are possessed by any living whale, this creature being by some authorities regarded as linking the whales with the seals. The fossil remains of Zeuglodon and its neighbors first occur in Eocene rocks—that is, in the oldest formations of the Tertiary series, and in rocks of relatively "recent" nature. These remarkable creatures were as gigantic as their living representatives. One species is known to have attained a length of seventy feet. Their remains are of such frequent occurrence in the "Jackson Beds" of the United States, that Professor Dana remarks: "The large vertebræ, some of them a foot and a half long and a foot in diameter, were formerly so abundant over the country in Alabama, that they were used for making walls, or were burned to rid the fields of them." The teeth of this curious monster of the vasty Eocene deep were of two kinds, and included front teeth of conical shape, and grinders or molars; the latter exhibiting a striking peculiarity in that they were formed each of two halves, or teeth united by their crowns, but separated at their roots. Zeuglodon appears to connect the whales and their neighbors with the seals and walruses, and thus in one sense may be said to constitute, if not a "missing link," at least an intermediate form of anomalous kind, when viewed relatively to the existing cetaceans. According to the geological evideuce at hand, we may assume that the modifications which have produced the existing whales and

their neighbors are of comparatively recent date, and that their adaptation to an aquatic life is a thing but of yesterday when compared with the duration of previous æons in the history of our globe.

Gentleman's Magazine.

A PROBLEM IN HUMAN EVOLUTION.

By Professor GRANT ALLEN.

"HARDLY any view advanced in this work," says the illustrious author of the "Descent of Man," "has met with so much disfavor as the explanation of the loss of hair in mankind through sexual selection." Indeed, the friends and foes of Mr. Darwin's great theories have been equally ready, the one party to disclaim and the other party to ridicule the account which the founder of modern philosophic biology has given of the process whereby man, as he supposes, gradually lost the common hairy covering of other mammalia. Mr. Wallace, with all his ability and ingenuity, finds it necessary to call in the aid of a *deus ex machina* to explain the absence of so useful and desirable an adjunct; for he believes that natural selection could never have produced this result, and he therefore feels compelled to put it off upon "some intelligent power," since he denies altogether the existence of sexual selection as a *vera causa*. Mr. J. J. Murphy, in his recently published revision of "Habit and Intelligence," has taken up the same ground with a more directly hostile intent; and Spengel has also forcibly given expression to his dissent on the plea of inadequate evidence for the supposed preference. It seems highly desirable, therefore, to prop up Mr. Darwin's theory by any external supports which observation or analogy may suggest, and if possible to show some original groundwork in the shape of a natural tendency to hairlessness, upon which sexual selection might afterward exert itself so as to increase and accelerate the depilatory process when once set up.

The curious facts for which we have to account are something more than the mere general hairlessness of the human species. In man alone, as Mr. Wallace clearly puts the case, "the hairy covering of the body has almost totally disappeared; and, what is very remarkable, it has disappeared more completely from the back than from any other part of the body. Bearded and beardless races alike have the back smooth, and even when a considerable quantity of hair appears on the limbs and breast, the back, and especially the spinal region, is absolutely free, thus completely reversing the characteristics of all other mammalia." When we consider the comparatively helpless condition to which man has been thus reduced, as well as the almost universal human practice of substituting artificial clothing,

derived from the skins or wool of other animals, for the natural apparel which the species has so unaccountably lost, it does not seem surprising that even Mr. Wallace should be staggered by the difficulty, and should fall back upon an essentially supernatural explanation.

The great key to the whole problem lies, it would seem, in the fact thus forced upon our attention, that the back of man forms the specially hairless region of his body. Hence we must conclude that it is in all probability the first part which became entirely denuded of hair. Is there any analogy elsewhere which will enable us to explain the original loss of covering in this the normally hairiest portion of the typical mammalian body? The erect position of man appears immediately to suggest the required analogy in the most hairless region of other mammals.

Almost all animals except man habitually lie upon the under surface of the body. Hence arises a conspicuous difference between the back and the lower side. This difference is seen even in lizards, crocodiles, and other reptiles, among which, as a rule, the tegumentary modifications of the under surface are much less extended and less highly differentiated than those of the upper. It is seen among birds, which usually have the plumage far less copious on the breast than on the back. But it is most especially noticeable in mammals, which have frequently the under side almost entirely bare of hair, while the back is covered with a copious crop. Now, it would seem as though this scantiness of natural clothing on the under side were due to long-continued pressure against the ground, causing the hair to be worn away, and being hereditarily transmitted in its effects to descendants. We are, therefore, led to inquire whether all parts of the mammalian body which come into frequent contact with other objects are specially liable to lose their hair.

The answer seems to be an easy one. The soles of the feet in all mammals are quite hairless where they touch the ground. The palms of the hands in the quadrumana present the same phenomenon. The knees of those species which frequently kneel, such as camels and other ruminants, are apt to become bare and hard-skinned. The callosities of the Old-World monkeys, which sit upon their haunches, are other cases in point; but they do not occur among the more strictly arboreal quadrumana of the American Continent, nor among the lemurs, for the habits of these two classes in this respect are more similar to those of ordinary mammals. On the other hand, the New-World monkeys possess a prehensile tail, with which they frequently swing from bough to bough or lower themselves to the ground, and in these creatures, says Cuvier, "la partie prenante de la queue est nue en dessous." Wherever we find a similar organ, no matter how widely different may be the structure and genealogy of the animals which possess it, we always find the prehensile portion free from hair. This is the case with the marsupial *tarsipes*, with many rodents, and

above all with the opossum, which uses its tail quite as much as any monkey uses its hands. Accordingly, its surface is quite bare from end to end, and in some species scaly—a fact which is rendered more comprehensible when we remember that the young opossums are carried on their mother's back, and hold themselves in that position by curling their tails around hers.

A few more special facts help to bear out the same generalization. In the gorilla, according to Du Chaillu, "the skin on the back of the fingers, near the middle phalanx, is callous and very thick, which shows that the most usual mode of progression of the animal is on all-fours and resting on the knuckles." The ornithorhyncus has a flat tail, on which it leans for support, and this, says Mr. Waterhouse, "is short, depressed, and very broad, and covered with coarse hairs; these, however, are generally worn off on the under side of the tail in adult or aged individuals, probably by the friction of the ground." The toes of the very large fore-feet, used in burrowing, are also naked, as are the similar organs in the mole and many other creatures of like habit. The beaver likewise uses his tail as a support, flaps it much in the water, and is said, perhaps not quite erroneously, to employ it as a trowel in constructing his dams; and this tail is entirely devoid of hair, being covered instead with a coat of scales. We can hardly avoid being struck in this instance, as in that of some seals' and sea-lions' flappers, with the analogy of the penguin's wings, which are employed like fins in diving, and have undergone a similar transformation of their feathers into a scale-like form. In the ground-kangaroos, which use the tail as a support trailing behind them on the ground, that organ is again only slightly covered with coarse hairs, almost entirely wanting on the extremity of the under surface; but in the tree-kangaroos, which carry the tail partly erect, it assumes a bushly and ornamental appearance. Like differences occur between the rats and mice on the one hand and the squirrels on the other. In those monkeys which, like *Macacus brunneus*, sit upon their tails, that organ is also bare. To multiply further instances would only prove tedious.

Again, when we look at the only mammals besides man which have denuded themselves of their hairy covering, we find that a great majority of them are water-frequenters. The most completely aquatic mammals, like the whales, porpoises, dugongs, and manatees, though differing widely in structure, are alike in the almost total absence of hair, while the hippopotamus is likewise a smooth-skinned animal. Now, the friction of water is of course far stronger than that of air, and it would seem to have resulted in the total depilation of these very aquatic species. Other less confirmed water-haunters, such as seals and otters, have very close fur, which scarcely at all retards them in their movements when swimming. The elephant and rhinoceros are, indeed, difficult cases to explain; but of course it is not necessary

to suppose that no other cause save that which we are considering can ever produce hairlessness. It will be enough if we can show that the cause actually under examination does with reasonable certainty bring about such an effect.

If, then, the portion of animals which generally comes in contact with the ground or other external bodies acquires in this manner a hairless condition—shown alike in hands, feet, tail, and belly—what will be the result upon animals which are gradually acquiring the erect position? Of this we can obtain an almost complete series by looking first at the beaver, which rests upon its scaly tail alone; then at the baboons, which rest upon the naked callosities on their haunches; thirdly, at the gorilla; and, last of all, at mankind.

The gorilla, according to Professor Gervais, is the only mammal which agrees with man in having the hair thinner on the back, where it is partly rubbed off, than on the lower surface. This is a most important approach to a marked human peculiarity, and is well worthy of investigation. "I have myself come upon fresh traces of a gorilla's bed on several occasions," says Du Chaillu, "and could see that the male had seated himself with his back against a tree-trunk. In fact, on the back of the male gorilla there is generally a patch on which the hair is worn thin from this position, while the nest-building *Troglodytes calvus*, or bald-headed *nshiego*, which constantly sleeps under its leafy shelter on a tree-branch, has this bare place on its side, and in quite a different way. . . . When I surprised a pair of gorillas," he observes elsewhere, "the male was generally sitting down on a rock or against a tree." Once more, in a third passage he writes: "In both male and female the hair is found worn off the back; but this is only found in very old females. This is occasioned, I suppose, by their resting at night against trees, at whose base they sleep." And, when we inquire into the difference between the sexes thus disclosed, we learn that the female and young generally sleep in trees, while the male places himself in the position above described against the trunk.

The gorilla has only very partially acquired the erect position, and probably sits but little in the attitudes common to man. But if a developing anthropoid ape were to grow more and more upright in his carriage, and to lie more and more upon his back and sides, we might naturally expect that the hair upon those portions of his body would grow thinner and thinner, and that the usual characteristics of the mammalia as to dorsal and sternal pilosity would be completely reversed. This is just what has probably happened in the case of man. In proportion as he grew more erect, he must have lain less and less upon his stomach, and more and more upon his back or sides. For fully developed man, with the peculiar set of his neck, face, and limbs, it is almost impossible to rest upon his stomach. On the other hand, all savage races lie far more upon their backs than even Europeans with their sofas, couches, and easy-chairs; for the natural posi-

tion of savage man during his lazy hours is to stretch himself on the ground in the sun, with his eyes closed, and with his back propped, where possible, by a slight mound or the wall of his hut. Any person who has lived much among negroes or South Sea Islanders must have noticed how constant is this attitude with men, women, and children, at every stray idle moment.

Nor must we forget the peculiar manner in which human mothers must necessarily have carried their infants from a very early period in the development of our race. During the first eighteen months of life the human infant must always be held, or laid, more or less upon its back; and this position will probably tend to check the development of hair upon the dorsal and lateral regions.

Next, let us ask what is the actual distribution of hair upon the body of man. Omitting those portions where the ornamental use of hair has specially preserved it, the most hairy region is generally, so far as my observations go, the fore part of the leg or shin. Obviously this is a region very little likely to come in contact with external objects. On the other hand, the most absolutely hairless places are the palms of the hands and the soles of the feet, after which come the elbows, and at a long interval the knees and knuckles. The back is very hairless, and so are the haunches. But the legs are more hairy than the body, both in front and behind, though less hairy on the calf than on the shin. Now, it will be obvious that both by day and night we rest more upon our backs and haunches than upon our legs, the latter being free when we sit down on a chair or bench, doubled in front of us when we squat on the ground (the normal position of savages), and thrown about loosely when we lie down. Especially might we conclude that this would be the case with early races, unembarrassed by the weight of bedclothes. As for the arms, it is noticeable that they still retain the ordinary mammalian habit in being hairier on the back than on the front; and this also is quite in accordance with our present suggestion, because the same differentiating causes have not worked upon the arm as they work upon the back and legs. The peculiar position of the anterior extremities in man, together with the erect posture, makes the arms come much more frequently into frictional contact with the body or clothing on their inner than on their outer surface. Hair grows most abundantly where there is normally least friction, and *vice versa*. As for the hair which frequently appears upon the chest of robust Europeans and others, I shall return to that point at a later stage. It may be noted, however, that while the first joint of the fingers is hairy, the second joint, answering to the callosity of the gorilla, is generally bare.

As man, then, gradually assumed the erect attitude and the reversed habits of sitting and lying down which it necessarily involves, it seems to me that he must have begun to lose the hair upon his back. But such a partial loss will not fully account for his present very hair-

less condition over the whole body (with trifling exceptions) in the average of all sexes, races, and ages. For this further and complete denudation I think we must agree with Mr. Darwin in invoking the aid of sexual selection, especially when we take into consideration the ornamental and regular character of the hairy adjuncts which man still retains.

In the first place, we have external reasons for believing that sexual selection has produced similar results elsewhere, acting upon a like basis of natural denudation. For among the mandrills and some other monkeys the naked callosities, originally produced, as is here suggested, by physical friction, have been utilized for the display of beautiful pigments; and Mr. Bartlett informed Mr. Darwin that as the animals reach maturity the naked surfaces grow larger in comparison with the size of the body. When we look at the great definiteness and strange coloring of these bare patches we can hardly doubt that they have been subjected to some such selective process.

But if man once began to lose the hair over the whole of his back, shoulders, and haunches, as well as more partially upon his sides, legs, and arms, he would soon present an intermediate half-hairy appearance which is certainly very ludicrous and shabby-looking. Why this middle stage should displease us, it might be rash to guess; yet one may remember that as a rule throughout the mammalia a partially hairless body would be associated with manginess, disease, and deformity. At any rate, it seems to be the fact that, when animals once begin losing their hair, they go on to lose it altogether. One may well believe that among our evolving semi-human ancestors those individuals which had most completely divested themselves of hair would be the most attractive to their mates; and these would also on the average be those which had most fully adopted the erect attitude with its accompanying alterations of habit. Thus natural selection would go hand in hand with sexual selection (as I believe it always does), those anthropoids which most nearly approached the yet unrealized standard of humanity being most likely to select one another as mates, and their offspring being most likely to survive in the struggle for life with their less anthropoid competitors.* It does not seem probable, to me at least, that a naturally hairy species would entirely divest itself of its hair through sexual selection, especially as the first steps of such a process could hardly fail to render it a mongrel-looking and miserable creature; but it seems natural enough that, if the original impulse was given by a physical denudation, the influence of sexual selection would rapidly strengthen and complete the process. Indeed, if a hairy animal once began losing its hair, the only beauty which it could aim at would be that of a smooth and shiny naked black skin.

Woman is the sex most affected in mankind by sexual selection, as

* On the advantages which man or his half-developed ancestor derived from the erect or semi-erect position, see Darwin, "Descent of Man," p. 53.

has been often abundantly shown. Hence we should naturally expect the denudation to proceed further in her case than in that of man. Especially among savage and naked races we should conclude that hairlessness on the body would be esteemed a beauty; and we find as a matter of fact that most such races have absolutely smooth and glistening skins. But in Europe men often develop hair about the chest and legs, though not upon the back and shoulders, while women seldom or never do so. Here we see that the hair reappears in the less differentiated male sex rather than in the more differentiated females, with whom sexual selection has produced greater effects; while it also reappears only on those parts where the original denudating causes do not exert any influence. Similarly, the smooth-bodied negroes, transported to America, and subjected at once to a change of conditions and to circumstances which would render sexual selection impossible as regards the hairlessness of the body, rapidly redevelop hair upon the chest. For we must remember that sexual selection can only act in this direction while a race remains wholly or mainly naked. Clothing, by concealing the greater part of the skin, necessarily confines the selective process to features, complexion, and figure.

As to the poll, beard, whiskers of certain races, we must believe that they are the result of selective preferences acting upon general tendencies derived from earlier ancestors, and perhaps aided in the first-mentioned instance by natural selection. The comparative definiteness of these hairy patches, as of the callosities in the monkeys, stamps them at once as of sexual origin. The poll is probably derived by us from some of our anthropoid ancestors, as crests of hair frequently appear upon the heads of the quadrumana. But as man gradually became more erect and less forestine, as he took to haunting open plains and living more in the sunlight, the existence of such a natural covering, as a protection from excessive heat and light upon the head, would doubtless prove of advantage to him; and it might, therefore, very possibly be preserved by natural selection. Certainly it is noticeable that this thick mat of hair occurs in the part of his body which the erect position most exposes to the sunlight, and is thus adaptively analogous to the ridge of hair which runs along the spine or top of the back in many quadrupeds, and which is not visible in any quadrumanous animal that I have examined. The beard also bears marks of a quadrumanous origin, as Mr. Darwin has shown; but its varying presence or absence in certain races affords us a good clew to the general course of evolution in this particular. For among the bearded races a fine and flowing beard is universally admired; while among the beardless races stray hairs are carefully eradicated, thus displaying the same aversion to the intermediate or half-hairy state which, as I suppose, has been mainly instrumental in completely denuding the body of man. Certainly it is a fact that while we can admire a European with a full and handsome development of hair

upon the chin and lip, and while we can admire an African or a North American Indian with a smooth and glossy cheek, we turn with dislike from thin and scanty hair either in a European, a negro, or an Asiatic. It seems to me that in every case the general æsthetic feeling of the whole human race is the same; but that in one tribe circumstances have made it easier to produce one type of beauty, while in another tribe other conditions have determined the production of another type. Thus, in a negro, a very black and lustrous skin, clear bright eyes, white teeth, and a general conformity to the normal or average negro features are decidedly pleasant even to Europeans when once the ordinary standard has become familiar;* while in a European the same eyes and teeth are admired, but a white skin, a rosy complexion, and moderate conformity to the ideal Aryan type are demanded. Each is alike pretty after its own kind, though naturally the race to which we each ourselves belong possesses in most cases the greatest attractiveness to each of us individually.

Of course, both in the beard of man, and in the general hairiness of his body, as compared with woman, allowance must be made for that universal tendency of the male to produce extended tegumentary modifications, which, as Mr. Wallace has abundantly shown, depends upon the superior vigor of that sex. Yet the period when the beard first shows itself and the loss of color in the hair of both sexes after the reproductive period is past clearly stamp these modifications as sexual in origin.

It must be remembered also, in accounting for the general loss of hair on both back and front of the body, that the older ancestral heredity would tend to make the chest bare, and the newer acquired habits would tend to produce like results upon the back. "In the adult male of the gorilla," says Du Chaillu, "the chest is bare. In the young males which I kept in captivity it was thinly covered with hair. In the female the mammæ have but a slight development and the breast is bare." All this helps us to see how the first steps in the sexually selective process might have taken place, and also why the trunk is on the whole more denuded than the legs. As for the exceptional fact that the arms are hairier on the back than in front, besides the functional explanation already given, we must recollect that the anthropoid apes have long hair on the outer side of the arms, which has probably left this slight memento of its former existence on the human subject. Eschricht has pointed out the curious fact that alike in man and the higher quadrumana this hair has a convergent direction toward the point of the elbow, both from above and from below.

Finally, it may be noted that the hairless condition of man, though

* The mutilations of the face and other parts, which often make savages so ugly in our eyes, though not in their own, are due, as Mr. Herbert Spencer has shown, not to æsthetic intentions, but to originally subordinative practices, as marks of subjection to a conquering king or race.

apparently a disadvantage to him, has probably been indirectly instrumental in helping him to attain his present exalted position in the organic scale. For if, as is here suggested, it originally arose from the reactions of the erect attitude, it must have been associated from the first with the most human-like among our ancestors. Again, if it was completed by sexual selection, it must also have been associated with the most æsthetic individuals among the evolving species. And if, as we have seen reason to believe, these two qualities would tend to accompany one another, then this slight relative disadvantage would be pretty constantly correlated with other and greater advantages, physical and intellectual, which enabled the young species to hold its own against other competing organisms. But, granting this, the disadvantage in question would naturally spur on the half-developed ancestors of man to seek such artificial aids in the way of clothing, shelter, and ornament, as would ultimately lead to many of our existing arts. We may class the hairlessness of man, therefore, with such other apparent disadvantages as the helpless infancy of his young, which, by necessitating greater care and affection, indirectly produces new faculties and stronger bonds of union, and ultimately brings about the existence of the family and the tribe or nation. And if we look back at the peculiarities which distinguish placental from implacental mammals, the mammalia generally from birds, and birds from reptiles, we shall see that in every case exactly similar apparent disadvantages have been mainly instrumental in producing the higher faculties of each successive vertebrate development. Hence it would seem that the hairless condition of man, instead of requiring for its explanation a special intervention of some supernatural agent, is strictly in accordance with a universal principle, which has brought about all the best and highest features of the most advanced animal types through the unaided agency of natural selection.—*Fortnightly Review.*

SKETCH OF PROFESSOR CLIFFORD.

WILLIAM KINGDON CLIFFORD was born at Exeter, May 4, 1845, and at the time of his death, which occurred on the 3d of March, he had therefore not reached the age of thirty-four years. His father was a justice of the peace, and his mother, from whom he inherited a portion of his genius and his constitutional weakness, died early. He first attended the school of Mr. Templeton, of that city, and went to King's College, London, in 1860. In 1863 he entered at Trinity College, Cambridge, in which he secured a foundation scholarship and got the honor of second wrangler in the mathematical Tripos of 1867. Soon after taking his degree he was elected to a fellowship

at Trinity College, filling the post until his appointment to the chair of Applied Mathematics and Mechanics at University College, London, in August, 1871, a position which he held until his death. Professor Clifford was elected a Fellow of the Royal Society in June, 1874. He took prizes and honors wherever he went, which was the more remarkable, as his mind could not tolerate the usual school restraints, and he could not be induced to give much attention to the regular subjects of examination. He had consumption, which greatly impaired his working power in the latter portion of his life; and he died on the island of Madeira, where he had gone with his wife and two children to get the benefit of its milder climate.

Clifford was a genius, and brilliant from his boyhood. He early developed rare mathematical talent, and published the "Analogues of Pascal's Theorem" in the "Quarterly Journal of Mathematics" at the age of eighteen. His mind was at home in all highest mathematical questions, to which he made many profound and original contributions. Professor Sylvester remarked, "All that Professor Clifford adds is the very pith and marrow of the matter." Just before his death he published a little mathematical work, "The Elements of Dynamic," in which his faculty for the subject is fully displayed. It will probably not take high rank as a university text-book, for which it was intended, but is admired by mathematicians for the elegance, freshness, and originality displayed in the treatment of mathematical problems.

Clifford had no special taste for the acquisition of languages, but was interested in their mechanism, and took interest in short-hand, phonography, and telegraphic alphabets. Later in life, however, he mastered modern Greek and Spanish, and dabbled in Arabic and Sanskrit, which, in addition to his earlier Greek and Latin, French and German, landed him pretty heavily in the direction of vocabularies.

He was an early and devoted student of classics, and held extreme High-Church notions when he went to Cambridge. In his knowledge of the "Fathers" he is said to have surpassed the bishops, and his theological acquirements were of great use to him in his polemical and critical discussions. Not satisfied in addressing that very small portion of the public that understands mathematics, versatile in his powers, and of a restless temperament, he was powerfully attracted to those great subjects of scientific and speculative inquiry that have lately become so prominent in the world of thought. Into this field he entered vigorously, and made a strong impression upon the reading public by various able and elaborate articles which appeared in the "Fortnightly" and "Contemporary" Reviews, and in "The Nineteenth Century." He was an extreme and uncompromising rationalist, and although personally greatly liked on account of his gentleness and affability, he made many enemies by the relentless severity of his writing on topics that are conventionally handled with delicacy and caution. He discussed a variety of philosophical subjects, always in a striking and attractive

manner, but can hardly be said to have developed any theories or system of his own.

As an expositor, Professor Clifford was peculiarly and remarkably gifted. Aside from his mathematical attainments, this was the intellectual quality for which he was the most distinguished. His power in this direction is thus described by the "Pall Mall Gazette": "His faculty of explaining the results of scientific investigation in ordinary language, and to persons having little or no special preparation, was such as to amount of itself to genius. The grasp and width of his imagination enabled him to deal freely with the very ideas of the higher mathematics, unfettered by the symbolical expressions and machinery which had first made their conception possible; and he translated the ideas into forms of wonderful simplicity for hearers who little suspected the height and difficulty of the achievement. Long ago, in Cambridge days, he would discuss some complicated theorem of solid geometry, without aid of paper or diagram, in such a way as to make the whole thing seem visibly embodied in space and self-evident. Where the text-books gave a chaos of algebraical manipulation, he would instantly seize the real facts and relations and bring them out into manifest light. Nor did this power fail him even in the most arduous flights of modern geometrical speculation. He was the first in this country to see and enforce the important philosophical bearings of what is called imaginary geometry. His last published paper, which saw the light only a few days before we knew that his work was irrevocably ended, was devoted to explaining with singular felicity and clearness the ultimate foundations of the science of number." The capacity here referred to was so unique and remarkable in Professor Clifford as to win for him a somewhat exaggerated reputation for originality; that is, he would so vividly and ingeniously present a difficult subject as almost to make the views expounded his own.

Among his other accomplishments, Clifford was a skillful gymnast, and as original in his performances as in his intellectual work. He was always executing some striking or eccentric feat, such as hanging head downward, by his toes, and drinking a glass of wine without spilling it; or going up to his room in the college by the water-spout and through the window, instead of the regular staircase. He had more pride in the invention of adventurous and daring gymnastic feats than in his intellectual work. He seems, indeed, to have used his gymnastic exercises as expressions of his genius rather than as means of promoting health. He was of a slender constitution, which was ever on the strain, in one direction or another; and there is reason to think that he was deficient in the important art of taking care of himself, and that, if he had conformed to the first requirement of morality, the duty of doing good to the nature that was in his own charge, he might have done far more good to the world by a prolonged and increasingly useful life.

What shall we say of an education or a culture which not only fails to teach a man how to continue his own life, but which is itself the means of destroying it? On this point Clifford's intimate friend, Pollock, writing about him in "The Fortnightly Review," says: "This was the perilous excess in his own frame of nervous energy over constitutional strength and endurance. He was able to call upon himself, with a facility which in the result was fatal, for the expenditure of power in ways and to an extent which only a very strong constitution could have permanently supported; and here the constitution was feeble. He tried experiments on himself when he ought to have been taking precautions. He thought, I believe, that he was really training his body to versatility and disregard of circumstances, and fancied himself to be making investments when he was in fact living on his capital. At Cambridge he would constantly sit up most of the night working or talking. In London it was not very different, and once or twice he wrote the whole night through; and this without any proportionate reduction of his occupations in more usual hours. The paper on 'The Unseen Universe' was composed in this way, except a page or two at the beginning, at a single sitting which lasted from a quarter to ten in the evening till nine o'clock the following morning. So, too, was the article on Virchow's address. But Clifford's rashness extended much further than this one particular. He could not be induced, or only with the utmost difficulty, to pay even moderate attention to the cautions and observances which are commonly and aptly described as taking care of one's self. Had he been asked if it was wrong to neglect the conditions of health in one's own person, as well as to approve or tolerate their neglect on a larger scale, he would certainly have answered 'Yes.' But to be careful about himself was a thing that never occurred to him."

We append a portion of the estimate of Clifford made in the columns of the "Saturday Review": "The unexpected news of the death of Professor Clifford at Madeira will have brought sadness to an unusally large body of devoted friends, who had hoped that his strength had not waned so far that it might not be recovered under the influence of the mild climate to which he had gone. Nor will it be only by those who had the pleasure of a personal acquaintance with Professor Clifford that the news of his untimely death will be deeply felt. Few men who have passed away at so early an age have been so central a figure as he was in the view of a large portion of the most highly educated among us; and still fewer have achieved this distinction, while at the same time they retained the esteem and admiration of the select few who were competent to estimate their powers and know whether they had been put to a worthy use. But it was always his fate to be conspicuous in whatever circumstances or society he was placed. This was primarily due to his intellectual power, for, without the wonderful rapidity and vigor of thought which he possessed, such

a reputation as his could not have been sustained; but it was in no small degree due also to the peculiar originality of his character, both intellectual and moral, and to the absolutely tireless energy of his versatile mind.

"Those who remember Cambridge some ten or fifteen years ago will readily call to mind his fame while an undergraduate there. From the time when he came up to the university, with the high reputation which he had won while a schoolboy, to the time he left it some eight years afterward to become Professor of Mathematics at University College, London, he was more universally known and discussed among all classes at the university, whether undergraduates, graduates, or dons, than any of his contemporaries. He was indeed at all times a contrast to the normal type. At first, when fresh from school, he appeared as an ardent High Churchman, but he gradually became known as a devoted follower of Mr. Herbert Spencer, and as the champion of those views with which his name has since been identified. But, whatever was the precise phase of thought in which he might be, there was the same brilliant though paradoxical style of asserting and defending his beliefs which made him the terror of authorities and the delight of younger men. He never was in any sense the head of a party there. He was far too eccentric and original to have many followers or imitators. But no one had a wider circle of intimate friends, and no one could be in intimate intercourse with him without being deeply influenced by his views; and it was at that time chiefly by his direct influence on those personally acquainted with him that he produced his effect on the university. But the many-sidedness of his character caused this direct personal influence to be much more widely extended than would have seemed possible to those unacquainted with him. Gifted with an almost equal love for science, mathematics, history, and literature—we may even add gymnastics—he was the center of a knot of devotees of each of these studies, each of whom welcomed him as a comrade and regarded with jealousy his attention to other subjects as being likely to seduce him from the true bent of his genius into less important and congenial studies. And no doubt it was a fortunate thing in this instance that the arrangements for retaining the ablest men at the English universities are so imperfect, that Professor Clifford found no certainty of sufficient scope for his energies there, and resolved to leave that abode of learned leisure, and come to London, to become a mathematical professor, inasmuch as it was this that prevented him from wasting his life in desultory essays in a great variety of directions. No doubt all of these would have shown a power which would have made them remarkable, but they would have been dearly purchased by the sacrifice of the far greater and more abiding results that followed the concentration of his energies on the one or two subjects to which he devoted himself after his departure from the university.

"When resident in London the same qualities that had won him so

many friends at Cambridge still stood him in good stead, and he rapidly drew round him a large circle of warm friends and admirers, among whom might be found almost all the best known names in science or literature. This power of winning the affections of those who were most worthy of friendship was due mainly to the peculiarly winning gentleness and tenderness which characterized him, and made it impossible to resist the charm of personal intercourse with him. Although the nature of his opinions and his style of championing them raised him countless enemies among those who knew him only from his writings and lectures, yet there was no school of thought among the members of which he did not possess some intimate friends. However widely their opinions might differ, it seemed to be quite impossible for any one to feel hostility toward him after becoming personally acquainted with him. The versatility of his mind aided this greatly, for it gave to his conversation a charm which was quite peculiar, and which was felt alike by the most different classes of minds. There was no subject from which he used not to draw apt illustrations or expressive metaphors, which came clothed in language as quaint and as original as it was appropriate. Whatever he discussed seemed to become full of suggestiveness. These qualities gave great additional value to his mathematical lectures.

"With his style of teaching, the most valuable part of the instruction was the indirect effect of the lessons; the actual matter in hand was distinctly subordinate to the general training in the fundamental ideas and principles of the subject which its discussion enabled him to give. Everything was treated from the point of view in which it least needed the aid of artificial methods and conventions, so that its direct connection with the broad underlying principles common to a whole class of subjects might be immediately perceived. This dislike to artificial methods was almost a passion with him. He had great faith in the superiority of this style of teaching, and always maintained that it was the easiest as well as the best, a proposition to which the experience of most teachers would not lead them to assent. Perhaps it was his own special power of clear exposition which enabled him to succeed so well in thus handling his subjects in their most general form, instead of starting from simple and particular cases, and only taking up more general theorems after the simpler ones had been mastered by his pupils; but, whether or not this was the case, it is certain that he had all the success in his teaching that he could desire.

"It is a signal proof of the beauty of Professor Clifford's personal character that, in forming an estimate of him, one should so naturally and inevitably think first of his general qualities, and only in the second place of his claims to fame as a mathematician. For it was in the latter character that he first gained his great reputation, and it is in that that his claims to genius are the strongest. No one of his contemporaries ever approached Professor Clifford in his marvelous

power over the intricate and abstruse branches of mathematics to which he gave his main affections, and to find his equal we should have to look among veterans whose names will for ever be identified with these subjects. Such was his prodigious grasp over the phantoms that people these remoter regions of thought, that while little more than a boy he seemed fit to take his place among the masters of these studies. And there can be no doubt that, if the innate restlessness of his nature would have permitted him to accept the quiet of a mathematician's life, he might have left behind him what would have entitled him to take rank as one of our greatest mathematicians. But it is hard to forego the pleasure of using powers which one is conscious of possessing, and the temptation to which the versatility of his mind subjected him was wellnigh fatal to his reputation as a specialist. Every now and then something would turn his energy into these lines, and he would show by some fragment what magnificent work he was capable of doing; but it was for a long time doubtful whether he would ever do justice to himself in this respect, and by more continuous application to some special subject produce results worthy of his powers. As time went on, however, this changed; during the last few years there were fewer signs of the old desultoriness, and both in his 'Elements of Dynamic' and his various mathematical papers there were abundant traces of the concentration of effort which alone was needed to secure success. But, alas! this was only too speedily succeeded by the leisure of the sick-bed. Perhaps it was the feeling of decaying strength which first made Professor Clifford limit the sphere of his efforts, and seek to finish some of his many projects, instead of forming new ones. Whether this was so or not, it was not the less a gain to the world, though even now what we possess should be considered only as indications of what his powers would have been when fully developed. Few, if any, have done such brilliant work and yet died leaving us to feel that it must be taken only as the promise, and not as the measure, of their powers.

"But what the mathematical world lost in this want of specialization of Professor Clifford's powers was gained by the general educated public. His powers as a scientific expositor were as remarkable as his mathematical abilities. His talent did not lie in experimental illustration; on the contrary, he seldom, if ever, resorted to it. Nor did he ever condescend to the nurse-like prattle by which some scientific lecturers make themselves comprehensible to the meanest intellects—but to those only. There was not a sentence, or a scientific statement, in one of Professor Clifford's lectures of which he need have been ashamed in an address to the most scientific or learned society."

CORRESPONDENCE.

A CORRECTION.

To the Editors of the Popular Science Monthly.

IN your February number, the article on "The Old Phrenology and the New," by Dr. Andrew Wilson, struck me as having been conceived not only with some degree of prejudice, but a lack of sufficient care in reference to facts. I will refer you to one case which relates to Mr. Gage, who had an iron bar driven through his brain by a blasting accident. Dr. Wilson conveys the idea that his mental faculties were unaffected by this most extraordinary injury and loss of brain. Dr. J. M. Harlow, now of Woburn, Massachusetts, had charge of the case, and followed with great care the wanderings of this young man, after he recovered from his injury; and after his death, which occurred in California, twelve years after the accident, he was able to get the cranium and the iron bar that passed through it, and presented them, with a detailed account of the case, to the Massachusetts Medical Society; and they are now in the Museum of Harvard College. In this paper Dr. Harlow says, in reference to the changed condition of the mental faculties: "His physical health is good, and I am inclined to say he has recovered. Has no pain in head, but says it has a queer feeling which he is not able to describe. Applied for his situation as foreman, but is undecided whether to work or travel. His contractors, who regarded him as the most efficient and capable foreman in their employ previous to his injury, considered the change in his mind so marked that they could not give him his place again. The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operations, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. A child in his intellectual capacity and manifestations, he has the animal passions of a strong man. Previous to his injury, though untrained in the schools, he possessed a well-balanced mind, and was looked upon by those who knew him as a shrewd, smart business man, very energetic and persistent in executing all his plans of operation. In this regard his mind was radically changed, so decided that his friends and acquaintances said he was 'no longer Gage.'"

In this case of injury of the brain and recovery, unparalleled, and of world-wide interest, I deem it proper that the error in reference to the condition of the intellectual faculties should be corrected through your periodical. Truly,

JOHN CLOUGH.

WOBURN, MASSACHUSETTS, *March* 31, 1879.

EDITOR'S TABLE.

THE LONDON TIMES ON INTERNATIONAL COPYRIGHT.

THE circular of Messrs. Harper, announcing that they will favor an international copyright measure, is justly regarded by the English press as significant in relation to the progress of the question, and they have made it the occasion of general comment. The tone of criticism is dissonant and, on the whole, encouraging, though, as has become the habit, predominantly abusive and carping. But it must be confessed that Harpers' circular was somewhat calculated to provoke hostile English criticism. The conditions under which they are willing to concede to foreign authors the legal right of property in their works, which are not only that the books shall be manufactured in this country, but by American citizens, and published within three months after their issue at home, are denounced as so illiberal as to be hardly worth entertaining. The London "Times," in a first article upon the subject, was disposed to "welcome the result" on the ground that something is gained

when "the principle of piracy has been abandoned, and the black flag of literature hauled down." But in a second article the view taken is less favorable. It sees numerous difficulties, and thinks "there is very little use in discussing these farcical proposals which the publishers of the transatlantic cities have elaborated." It thinks the proposition to throw open the power of publishing books to everybody, subject to the obligation of paying a royalty to the author to be fixed by law, is "not yet sufficiently discussed." And so, on the whole, it concludes that we had better postpone the subject, and wait for something more satisfactory.

The "Times," however, is disingenuous in characterizing the plan suggested by Messrs. Harper as elaborated by the publishers of transatlantic cities. That house speaks only for itself, and does not undertake to represent other American publishers. Both the proviso that the publisher shall be an American citizen, and the time-limit assigned for reprinting, will be held by others as not essential to the American position, and as open to modification in settling the details of an international arrangement.

We speak of the "American position," and are fairly justified in doing so, for there is now wide and decisive agreement that foreign books copyrighted in this country, must be manufactured in this country. In granting the copyright to English authors, and placing them upon the same footing as our own, we yield all the rights of the case that can be demanded in the name of justice. Every nation that grants copyrights even to its own authors, qualifies and limits them by considerations of public expediency, it being assumed that the community has duties to itself as well as to authors. This country would therefore be vindicated by universal precedents in giving the new arrangements such a form that they will not be injurious to important American interests. The requirement that foreign books copyrighted in this country shall be printed in this country is dictated by the first law of nature—the principle of self-preservation. Any international copyright that did not enforce this condition would be destructive to an extensive and valuable domestic industry, and would put the American book-market at once and completely under the control of foreign publishers, thousands of miles away from us. Under a state of things which, although it may not have been just, has nevertheless been legal, the publishing interest in the United States has grown into extensive proportions. We have numerous manufacturing establishments of all kinds for every branch of the business. We have heavy investments in paper manufactories, printing-houses, binderies, and shops for making all the necessary machinery, and we have multitudes of trained mechanics to carry on the required operations.

Whether all this capital shall be sunk, and all this industry paralyzed, and a reading people shall cease to supply itself with books in accordance with its own tastes and preferences, depends upon the *form* of copyright adopted, if that measure is to be carried out. And when it is remembered that the foreign publisher has no claims upon us whatever, and that we discharge all our obligations in protecting the property rights of the foreign author, it is obvious that every consideration of national expediency dictates that we should take care of our own interests in this matter.

It is usual to represent the policy here maintained as inspired by the greed of mercenary and monopolizing American publishers. It is no such thing. It is life or death to the whole business. To yield the point is to transfer the American book-trade almost bodily to England. In requiring copyrighted books to be printed here, the American publisher only stipulates for

an equal chance with the English publisher, which he could not have if this measure is put upon any other basis. We say let the English publisher come over and compete with us if he wishes to. All we ask is equal terms, and that he shall not be given that fatal advantage of us which he would get by an unrestricted copyright.

But it may be said that this is an illiberal policy; and that, when all the tendencies of international intercourse are in the direction of freedom and expansion, such a scheme as this is narrow and obstructive. The "Times" virtually charges this, in saying "the gross delusions of protection may extend to cover the book-selling business as well as the making of cotton cloths and the forging of iron." And yet the burden of English complaint for the last fifty years has been that our trade in English books is quite too free, and our policy liberal and lax to a most scandalous extent. What they have demanded is, that we contravene this freedom of commerce by restrictive legislation. Copyright is the antagonist of free trade. Were perfect liberty of commerce proclaimed to-morrow between nations (as it now exists between the States of this nation), international copyright would make books an exception by protecting them from all competing production and open traffic. The author by his copyright invests his publisher with a monopoly, by which he controls and restricts the trade in his book to any extent that pleases him. With an unqualified international copyright, and the fullest freedom of trade otherwise, the London publishers would rule the market in this country for all the works of English authors. American publishers would be excluded from competition with them. We hold that the principle of copyright is wise, as it is the only practical way yet devised by which an author can have secured to him the available right of property in his book, and we demand that English authors shall have the full benefit of it, but on no principle of liberal trade arrangements can we be asked to subject our book markets to the exclusive control of English manufacturers.

The "Times" says that the great American houses have been driven into this position of favoring an international copyright, by the interference of "some Chicago men" who are cutting into and underselling the established firms of New York and Philadelphia. That cut-throat proceeding, as it is a natural consequence of the existing system, is certainly a valid reason for condemning the system and putting an end to it. But the "Times" misrepresents the facts in saying that this is the origin of the plan of international copyright now under consideration. Its own columns might have been consulted for a confutation of the statement. The project of international copyright, in behalf of English authors, was urged long before the Chicago raids referred to were undertaken, and it was explicitly presented to the English people by an American publisher writing in the "Times" as early as 1871.

The writer objects that, by the plan proposed, "the English author is not to be allowed the rights of an ordinary possessor of property." But does it expect that the Americans will go further than the English themselves, in protecting the rights of their authors? Is it not now, and has it not long been, the policy of the English Government to deny to its authors "the rights of an ordinary possessor of property" in his literary creations, and does it not protect them as mere favors and transient privileges which are left to expire after a few years? Again, the writer in the "Times" accuses us of robbing the author of *half* his rights. He may, if so minded, take the remainder, as "half the recognition of a right must have some value." To be paid the full price for his work, according to contracts that he may make with any publisher among

forty millions of people, thus appears to be only half what we owe to the English author. The implication is, that his right to force his foreign publisher upon us is just as clear and strong as his right of property in the book he has produced. This absurd proposition is of course assumed—not argued.

CURIOUS SURVIVALS OF SAVAGISM.

SINGULARLY enough, the time when men know least of this world is the time when they profess to know most of the other. The primitive man is first of all a believer in ghosts. While so ignorant that he can not count ten, he yet has a theory of a future life. Strip the civilized man of his acquirements and get down to the primal core of savagery, and you find him a spiritualist. At a time when all interpretations of nature were illusive, and in fact engendered by these illusions, there arose the notion of a ghost realm, occupied by phantoms of the departed dead, who can still communicate with living men and interfere in human affairs. And, as these causes are common to the lowest tribes, so the superstitions are universal in the savage state.

And they were not mere idle speculations. The other world was held to be of far greater moment to man than this world, because of the power of its spirits over the fate of mankind. But, although potent and dangerous, the ghosts of the dead were supposed to be still accessible to human influence. It was believed that they could be propitiated by supplications, offerings, and sacrifices, which took endless forms as religious rites among the lower races. So completely, indeed, were men enslaved to their spiritualistic fancies that life itself had not the slightest value when there was supposed to be some other-world inducement for destroying it. Men were immolated without hesitation to please or appease the ghosts of another sphere. This world was ruled with the most savage ferocity in the supposed interests of the next. The amount of human sacrifice—of deliberate butchery of human beings—that has been occasioned by gross spiritual delusions relating to another life is appalling to think upon. Starting with the idea of an imaginary sphere, filled with grim shadows to be placated or honored, men, women, and children have been slaughtered by countless thousands at religious altars, at funerals, and at tombs. Their souls were sent to accompany dead chiefs, wives were burned on funeral piles to accompany their husbands, some were sent to carry messages to the spirits, some to propitiate ill-natured demons, and the whole proceeding serves to demonstrate the terrible intensity of the primitive belief that the other world is everything and this world nothing.

These practices, originating in primeval spiritualism, in the infantine stages of society, are by no means confined to those stages; they continue on as society advances. Among the Mexicans, for example, after they had become considerably civilized, such was the bloody fervor of their spiritualism that human sacrifices, on a great scale, were part of their system of religious rites. We are told that "every great man's chaplain was slain to perform for him religious ceremonies in the next life as in this"; again, "The number of victims was proportioned to the grandeur of the funeral, and amounted sometimes, as historians affirm, to two hundred." Also, in Peru, "when an Inca died, his attendants and favorite concubines, amounting sometimes, it is said, to a thousand, were immolated on his tomb."

These ideas and practices having the most terrible sincerity and severity where the darkness of human ignorance is thickest, being most widespread and deeply rooted in the lowest barbarism,

we should expect that with the growth of intelligence they would disappear. But this process is very slow. The superstitions became the nucleus of organized religions, and are contained in a thousand theologies. Yet these beliefs at length lose their grosser forms; many of them are dissipated, others modified. They influence men's conduct less and less, and are finally held as mere empty traditional beliefs. Just in proportion to the increase of men's knowledge of nature, superstition has relaxed its stringency. As science grows, and the exploration and cultivation of this world become more absorbing, there is necessarily less attention given to the other world. This is deplored by many as a decline of faith. They raise loud lamentations over the decay of religion, the apathy of churches, the spread of materialism, and the extension and deepening of scientific influence. As a consequence, we now and then find men brooding over this state of things until the restraints of reason and common sense give way, and they announce themselves as divinely called upon to perform some great work that shall startle a faithless age, and kindle anew the old fervor of spiritualistic belief. Two such relapses into rank primeval superstition have recently occurred.

Charles F. Freeman, of Cape Cod, the other day piously sacrificed the life of his little daughter, in obedience to what he supposed to be a spiritual mandate from the other world. He was a Second Adventist, and full of intense belief in the miraculous coming of Christ to rescue the world from unbelief. Whether he attended the great Second Advent Convention that was held in New York last year we do not know, but he evidently laid to heart its inculcation of the duty of literally interpreting the Scriptures. He is reported as an assiduous Bible student, who quotes Scripture with great fluency, and is ready with an apposite text for every doctrine that he maintains. The old Hebrews indulged in the same sanguinary practices as other barbaric tribes. In their books there are records of one father sacrificing his daughter, and of another father preparing to immolate his only son. Freeman had, no doubt, often heard these transactions discussed in the pulpit, and Abraham applauded for the strength of his faith. If such a test was ever necessary, he thought it a thousand times more necessary in this faithless age than ever before; so he killed his child, at what he claims to be the peremptory requirement of the Deity he worshiped, that a miracle might be performed, and his faith displayed before an unbelieving generation. The whole ghastly affair is simply an instance of survival of one of the spiritual usages of savagery, when bloodthirsty devils were regular objects of worship.

Another case of falling back into the mental condition of barbarism has been recently afforded by the Superintendent of Schools of the City of New York, Mr. Henry Kiddle. Yielding to that morbid craving after the marvelous, which is a distinctive mark of undeveloped or retrograded natures, he had been exploiting mediums, and comes forward with what he calls a revelation from the spiritual sphere. Two members of his family have been for some time talking to him the most demented drivel, which he accepts as spiritual communications, or messages from the ghostly inhabitants of another world; all of which he has minutely written down and published in a book. Kiddle, like Freeman, as the newspapers avouch, is "very conscientious," "thoroughly sincere," "profoundly in earnest," etc., and there is no doubt of the genuineness of his credulity. We have looked over his book, and found it to consist of the merest rubbish. Mr. Kiddle says of these communications, in his preface, that he "*knows* they are not the offspring of imposture or delusion. *They come from the world of spirits.*

This is solemnly attested as a fact undeniable and irrefutable." Now, when Mr. Kiddle declares that he *knows* there is no delusion in the matter, he simply means that he solemnly believes it, which is the basis on which the mysteries of another world have been revealed from the earliest origin of these superstitions. He gives exactly the kind of evidence that would require us to believe all the insane hallucinations of our lunatic asylums, for no man is so undeniably and irrefutably sure that he is not deluded as a madman.

Freeman had a mission, and regarded himself divinely chosen for a great work. So does Kiddle. He is commissioned to open new relations with the unseen world. He announces "a new spiritual revelation," a "a new dispensation of religious light," showing "the existence of a future world." Under an "obligation imposed upon the editor by Divine Providence," he promulgates "a revelation of the future destiny of mankind, of transcendent importance to them both here and hereafter." And so all the *old* spiritual revelations are failures; the existence of a future world remained still to be proved; and the human race having struggled in vain for thousands of years to arrive at this truth of transcendent moment, Mr. Kiddle arrives at it by the aid of a couple of green mediums in the space of about nine months! Fortunate Mr. Kiddle!

Curiously enough, the Superintendent of Schools of the City of New York, who has given his life to the interests of knowledge, now gives notice that he has not a very high opinion of the later tendencies of science, and in this he is not alone. But he further intimates that his revelations of a supersensuous world may be designed by Heaven to thwart the influence of this bad science. We quote a passage from his introductory chapter, and beg the reader to notice that what follows is not from a spirit, but from Kiddle himself:

"When distinguished scientists sneeringly ask: '*Who has ever seen the soul* with the very best microscope that can be made? What physiologist *has ever found any human spirit* in his most minute dissections?'—when the proud scientist, filled with vainglory by the discovery of some of the laws of light and heat, or puffed up with vanity because he has caught a vision of something which he daringly calls the 'physical basis of life,' and, ready to fall down in adoration before his newfound deity, *Protoplasm*, announces that he finds in matter the 'promise and potency of every form of life;' or when he cries 'Amen' to his brother scientist who has traced, by the law of *evolution* and the 'survival of the fittest,' to a common origin himself and all the rest of the animal creation, and glories in his quadrumanous ancestry—when such is the age in which we live—an age characterized by the worst forms of irreligion—is it improbable that the All-Merciful Father should come again to the rescue of his benighted creatures, and for this purpose should in part unveil the glories of the supersensuous world to which all are tending?"

Mr. Kiddle's book, as this extract alone illustrates, is a very debilitated piece of intellectual work. Our first impression was that the man had undertaken to perpetrate a huge joke, but we became soon convinced that he is not himself. Various indications suggest an unhealthy state of mind, that is probably caused by some exhaustion or failure of the brain. The suddenness of his change of conduct at the age of fifty-five in regard to spiritualism; the slyness with which all was done, even to the printing of his book; his obstinacy in refusing to listen to reason and remonstrance in matters where others are concerned; and his egotistic hallucination in supposing himself divinely called upon to do a great religious work—these, taken in connection with the imbecile and idiotic

character of his book, show mental unsoundness, and suggest that the mind's organ is not in a proper condition. One thing is certain: the maker of such a book is not a fit man to be in charge of educational interests. If he is beside himself, that ends it; if not, the case is still worse: the Board of Education should have granted him leave of absence, and sent him away to recruit.

LITERARY NOTICES.

THE INTERNATIONAL SCIENTIFIC SERIES, No. XXVI.—MODERN CHROMATICS, WITH APPLICATIONS TO ART AND INDUSTRY. By OGDEN N. ROOD, Professor of Physics in Columbia College. With 130 Original Illustrations. D. Appleton & Co. Pp. 329. Price, $1.75.

IN his contribution to the "International Scientific Series" of a volume on modern chromatics, Professor Rood has filled a gap in the scientific literature not only of this, but also of European countries. There was wanted a well-executed popular treatise on the science of color for general readers, in which they will find a familiar and satisfactory explanation of chromatic phenomena as they are now interpreted, and as illustrated in the aspects of nature and in the applications of art.

Professor Rood was asked to prepare such a volume for this series because he possesses in an eminent degree the qualifications necessary to do justice to the subject. In the first place, he was specially prepared to undertake it by his education and training as an experimental physicist. At home in this general field of research, with an aptitude for subtile and refined investigations, he has always been particularly interested in this line of inquiry, and has attained a European reputation as an authority upon the subject. From this point of view, probably, no man was so well equipped to make an instructive volume on chromatics that should be fully up to the times as Professor Rood.

But he possesses another qualification which is no less important for the work. He is himself an artist, with both enthusiasm and a true genius for the profession, and who has devoted much time to drawing and painting. His sketches are prized by many who are so fortunate as to possess them, and it is well understood that, if he had chosen to devote himself to it, he would have attained preëminent distinction as an artist. This combination of scientific knowledge with practical experience in the art of managing colors could not fail to be of great advantage. Numerous questions and problems relating to chromatics which are interesting and important to artists came before him, and were elucidated with such skill and useful results that he was called upon to give lectures, explaining his views, before the art classes at the New York Academy of Design.

When solicited to prepare the present volume, Professor Rood replied that he was not a book-maker, and had no inclination merely to compile or to write a volume upon the science of color. He said that to make such a book valuable in the present state of the subject would involve a very considerable amount of scientific investigation in clearing up numerous points to get the work in anything like satisfactory shape. For these researches time would be necessary, which would inevitably delay the publication. The volume was prepared under these conditions, so that, in a very important sense, it is a new work. Every chapter of it bears witness to the patient and painstaking solicitude of the author to make his statements clear, valid, and complete. A consultation of his index will show to how large a degree the volume is original. Only results and explanation are given in the text, and those who care to go over the experimental demonstrations by which they have been reached will consult the scientific periodicals in which the descriptive papers are to appear.

Professor Rood, as we have intimated, declines to classify himself as a book-maker, and does not seem to have ever been troubled in the slightest degree with the ambition of authorship. He has written many technical papers for scientific journals, which may be thought rather a poor apprenticeship for getting up a popular book. But he has attained a degree of excellence in the literary art of his book which is not a

little surprising; it has the rare merit of being written in a style suited to its object. It is clear, simple, direct, and puts the matter before the reader in a straightforward, common-sense way, so as thoroughly to interest him in the subject.

The work is full of fresh illustrations, drawn by the author, and exhibiting new points and relations of the subject, and a chromatic plate is prefixed to the volume, which has something the character of a key, and will be specially useful to those who may desire to color the diagrams in the book. One of the most interesting features of the volume is the large number of instructive and attractive experiments in colors which it describes or indicates.

The work is strictly systematic, and treats the subject of chromatics comprehensively, as will be seen by glancing at the titles of the chapters.* We can give no idea of the real scope of the work by any analysis of its contents, or even a conspectus of the new ideas and suggestions contributed by the author; but some of his observations in Chapter XVIII., on "Color in Painting and Decoration," are so suggestive in relation to a subject occupying a good deal of public attention at present, that we quote them:

> The aims of painting and decorative art are quite divergent, and as a logical consequence it results that the use made by them of color is essentially different. The object of painting is the production, by the use of color, of more or less perfect representations of natural objects. These attempts are always made in a serious spirit; that is, they are always accompanied by some earnest effort at realization. If the work is done directly from nature, and is at the same time elaborate, it will consist of an attempt to represent, not all the facts presented by the scene, but only certain classes of facts, namely, such as are considered by the artist most important or most pictorial, or to harmonize best with each other. If it is a mere sketch, it will include not nearly so many facts; and finally, if it is merely a rough color-note, it will contain perhaps only a few suggestions belonging to a single class. But in all this apparently careless and rough work the painter really deals with form, light and shade, and color, in a serious spirit, the conventionalisms that are introduced being necessitated by lack of time or by choice of certain classes of facts to the exclusion of others. The same is true of imaginative painting: the form, light and shade, and color are such as might exist or might be imagined to exist; our fundamental notions about these matters are not flatly contradicted. From this it follows that the painter is to a considerable extent restricted in the choice of his tints; he must mainly use the pale unsaturated colors of nature, and must often employ color-combinations that would be rejected by the decorator. Unlike the latter, he makes enormous use of gradation in light and shade and in color; labors to express distance, and strives to carry the eye beneath the surface of his pigments; is delighted to hide as it were his very color, and to leave the observer in doubt as to its nature.
>
> In decorative art, on the other hand, the main object is to beautify a surface by the use of color rather than to give a representation of the facts of nature. Rich and intense colors are often selected, and their effect is heightened by the free use of gold and silver or white and black: combinations are chosen for their beauty and effectiveness, and no serious effort is made to lead the eye under the surface. Accurate representations of natural objects are avoided; conventional substitutes are used; they serve to give variety and furnish an excuse for the introduction of color, which should be beautiful in itself apart from any reference to the object represented. Accurate, realistic representations of natural objects mark the decline and decay of decorative art. A painting is a representation of something which is not present; an ornamented surface is essentially not a representation of a beautiful absent object, but is the beautiful object itself; and we dislike to see it forsaking its childlike independence and attempting at the same time both to be and to represent something beautiful. Again, ornamental color is used for the production of a result which is delightful, while in painting the aim of the artist may be to represent sorrow, or even a tragic effect. From all this it follows that the ornamenter enjoys an amount of freedom in the original construction of his chromatic composition which is denied to the painter, who is compelled by profession to treat nature with at least a fair degree of seeming respect. The general structure of the color-composition, however, being once determined, the fancy and poetic feeling even of the decorator are compelled to play within limits more narrow than would

* Chapter I., Transmission and Reflection of Light; II., Production of Color by Dispersion; III., Constants of Color; IV., Production of Color by Interference and Polarization; V., Colors of Opalescent Media; VI., Production of Color by Fluorescence and Phosphorescence; VII., Production of Color by Absorption; VIII., Abnormal Perception of Color and Color-Blindness; IX., Young's Theory of Color; X., Mixture of Colors; XI., Complementary Colors; XII., Effects produced on Color by a Change of Luminosity, and by mixing it with White Light; XIII., Duration of the Impression on the Retina; XIV., Modes of arranging Colors in Systems; XV., Contrast; XVI., The Small Interval and Gradation; XVII., Combinations of Colors in Pairs and Triads; XVIII., Painting and Decoration.—Note on Two Recent Theories of Color.—Index.

be supposed by the casual observer. It is not artistic or scientific rules that hedge up the path, but his own taste and feeling for color, and the desire to obtain the best result possible under the given conditions. In point of fact, color can only be used successfully by those who love it for its own sake apart from form, and who have a distinctly developed color-talent or -faculty; training, or the observance of rules, will not supply or conceal the absence of this capacity in any individual case, however much they may do for the gradual color-education of the race.

From the foregoing it is evident that the positions occupied by color in decoration and in painting are essentially different, color being used in the latter primarily as the means of accomplishing an end, while in decoration it constitutes to a much greater degree the end itself. The links which connect decoration with painting are very numerous, and the mode of employing color varies considerably according as we deal with pure decoration, or with one of the stages where it begins to merge into painting.

The simplest form of color-decoration is found in those cases where surfaces are enlivened with a uniform layer of color for the purpose of rendering their appearance more attractive: thus woven stuffs are dyed with uniform hues, more or less bright; buildings are painted with various sober tints; articles of furniture and their coverings are treated in a similar manner.

The use of several colors upon the same surface gives rise to a more complicated species of ornamentation. In its very simplest form we have merely bands of color, or geometrical patterns made of squares, triangles, or hexagons. Here the artist has the maximum amount of freedom in the choice of color, the surfaces over which it is spread being of the same form and size, and hence of the same degree of importance. In such cases the chromatic composition depends entirely on the taste and fancy of the decorator, who is much less restricted in his selection than with surfaces which from the start are unequal in size, and hence vary in importance. After these simplest of all patterns follow those that are more complicated, such as arabesques, fanciful arrangements of straight and curved lines, or mere suggestions taken from leaves, flowers, feathers, and other objects. Even in these, the choice of the colors is not necessarily influenced by the actual colors of the objects represented, but is regulated by artistic motives, so that the true colors of objects are often replaced even by silver or gold. Advancing a step, we have natural objects, leaves, flowers, figures of men or animals, used as ornaments, but treated in a conventional manner, some attention, however, being paid to their natural or local colors, as well as to their actual forms. In such compositions the use of gold or silver as backgrounds or as tracery, also the constant employment of contours more or less decided, the absence of shadows, and the frank disregard of local color where it does not suit the artist, all emphasize the fact that nothing beyond decoration is intended. Up to this point the artist is still guided in his choice of hues by the wish of making a chromatic composition that shall be beautiful in its soft, subdued tints, or brilliant and gorgeous with its rich display of colors; hence intense and saturated hues are often arranged in such a way as to appear by contrast still more brilliant; gold and silver, black and white, add to the effect; but no attempt is made to imitate nature in a realistic sense. When, however, we go some steps further, and undertake to reproduce natural objects in a serious spirit, the whole matter is entirely changed; when we see groups of flowers accurately drawn in their natural colors, correct representations of animals or of the human form, complete landscapes or views of cities, we can be certain that we have left the region of true ornamentation and entered another which is quite different. A great part of our modern European decoration is really painting—misapplied.

"AMERICAN CHEMICAL JOURNAL." Edited, with the Aid of Chemists at Home and Abroad, by IRA REMSEN, Professor of Chemistry in the Johns Hopkins University. Vol. I., No. 1. Fifty cents per number. Baltimore: Innes & Co.

As we gather from the announcement, the first object of this new Journal will be to collect the good original papers written by American chemists. It will aim to be a medium of communication between the chemists of this country by recording their researches. But at the same time it will reprint articles and abstracts of articles from other chemical periodicals, and will also print reports of progress in recent investigations and reviews of chemical publications. The first number opens with an article contributed by Dr. Wolcott Gibbs, on the complex inorganic acids, and closes with a report on applied chemistry, by Professor J. W. Mallet. The numbers of the Journal will contain from sixty-four to eighty pages. Six will form a volume of from four to five hundred pages, which will probably appear within a year. Subscription, three dollars per volume in advance. All success to the new enterprise!

JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, Vol. I., Nos. 1–3. Committee on Papers and Publications: H. Endemann, Ph. D., Editor; Arno Behr, Ph. D.; Gideon H. Moore, Ph. D. New York: Lehmaier & Brother, 162 William Street.

"THE American Chemical Society," though young, is vigorous, and is going on from strength to strength. It has already

a strong membership, and is doing a good deal of valuable work. The Society has permanent rooms at No. 11 East Fourteenth Street, which are open every evening from eight to ten o'clock. The "Journal of the American Chemical Society," like the "American Chemical Journal," is designed not for the outside world, but for those initiated into the mysterious technicalities of the science.

TREATISE RELATIVE TO THE TESTING OF WATER-WHEELS AND MACHINERY. With Various other Matters pertaining to Hydraulics. By JAMES EMERSON. Second edition. Springfield, Mass.: Weaver, Shipman & Co. Pp. 216.

THIS book has an interest for manufacturers using water-power. It seems that not long ago the testing of water wheels, with a view to determining their efficiency, was so difficult and expensive an operation, that the proprietors of new patent wheels of all kinds were tempted to make gross exaggerations of their effectiveness, because there were no ready means of getting at the actual facts. The author of this work accordingly addressed himself to the task of finding out some cheaper and more available means of making trustworthy measurements. This volume is chiefly devoted to that technical subject, and abounds in pictures of water-wheels, and formidable tables. It also gives much information regarding other forms of mechanism.

AN OUTLINE OF GENERAL GEOLOGY. With Copious References designed for the Use of both General and Special Students. By THEODORE B. COMSTOCK, B. Ag., B. S., of the Cornell University. Ithaca: University Press. Pp. 82.

THIS is a *vade mecum* for the use of geological students that has grown out of the author's syllabus of elementary lectures, to a mixed class of students, on economic geology and paleontology. It does not profess to be a text-book, but a help to study in connection with such works as Dana's "Manual of Geology" and Le Conte's "Elements of Geology." It gives summaries of important information and many useful references, blank leaves being freely inserted for convenience in making notes. Such a volume can not fail to facilitate the student's work in various ways.

SEWER-GASES, THEIR NATURE AND ORIGIN, AND HOW TO PROTECT OUR DWELLINGS. By ADOLFO DE VARONA, A. M., LL. B., M. D., etc. Brooklyn: "Eagle" Book Printing Department. 1879. Pp. 156. Price, 75 cents.

THIS little book contains much valuable information that every householder in our cities and towns should be familiar with. Many of the worst diseases are now believed to owe their origin to sewer or kindred emanations which find their way into houses, through defective planning and workmanship, both of which could be avoided if those most interested would take the trouble to inform themselves on the subject. In the present work the composition of sewer-gas, as determined by various competent analysts, is first considered; the relation of these gases to disease is next treated; then comes a description of the conditions under which sewer-gases are generated, the size, form, and construction of sewers, and the manner in which the sewer is connected with the house: this completes the first part of the book. The second part is devoted to the subject of the protection of dwellings against the entrance of sewer-poison. The author confines himself to facts and their common-sense applications; and, although the information which he gives may probably be obtained elsewhere, it is here brought together in a brief and convenient form, and unencumbered with the trash that characterizes so many works on hygienic subjects. The style of binding and display on the cover are hardly in keeping with the contents of the book, but this maybe remedied in a future edition.

READING AS A FINE ART. By ERNEST LEGOUVÉ, of the Académie Française. Translated from the Ninth Edition by ABBY LANGDON ALGER. Boston: Roberts Brothers. Pp. 97. Price, 50 cents.

A VERY suggestive and useful little monograph on the subject of reading aloud. The writer believes in an art of reading, which is capable of being generally acquired, and he certainly makes out a very good case. He gives the rules for reading, and deals with the philosophy of declamation in a very lively and pleasant manner, which has been well rendered in an excellent translation.

OCEAN WONDERS: A COMPANION FOR THE SEASIDE. Freely illustrated from Living Objects. By WILLIAM E. DAMON. New York: D. Appleton & Co. Pp. 229. Price, $1.50.

THIS is an elegant little volume, profusely and beautifully illustrated, and abounding in descriptions of those curious creatures of the sea, most of which can be actually observed by the dwellers upon the shore. It is hence very properly designated as a companion for the seaside. But that which is unique in the volume, and gives it its peculiar value, is the author's first-hand familiarity with his subject, and the large amount of trustworthy, practical information it contains, that will be of use to those who wish to make collections for themselves. In this respect the author's testimony is emphatic and decisive. He says: "It is not so easy as it appears at the first glance to assure success in establishing a private aquarium. Whatever value this volume possesses is due to the fact that I give no second-hand directions, but the results and deductions of my own dearly bought personal experience, attained at a considerable outlay, not only of time and trouble, but also of money, in obtaining many rare and scarce specimens of marine life, and in experiments to ascertain the kind of animals which would survive captivity. In the latter, I hope my directions or hints will materially diminish the amount of expenditure for such amateurs as may peruse this book."

The volume is admirably written, but of this our readers may judge for themselves, as some of Mr. Damon's contributions to natural history have already appeared in "The Popular Science Monthly."

THE LIFE AND LETTERS OF FRANCES BARONESS BUNSEN. By AUGUSTUS J. C. HARE. Two volumes in one. New York: Routledge & Sons. Pp. 1,002. Price, $5.

FRANCES WADDINGTON was the daughter of an English baronet, who lived in Wales. When she was at the age of eighteen, the family visited Rome, and she there met, captivated, and married young Charles Bunsen, a German, and afterward distinguished as a diplomatist and historian. They lived some twenty years in Rome, during which Bunsen represented the Prussian Government in an official capacity; and he was then sent to London to represent Prussia at the Court of St. James. He retained this position, residing in London, about a dozen years, when the family returned to Germany. The Baroness was a woman of remarkable character, who had a long career in the most favored circles of English and Continental society. She left the record of her observations and experience in a great number of letters, which her biographer, Mr. Hare, has made free use of in editing the work. She had a large family, to which she was greatly devoted, and the history of her life is an eminently wholesome and instructive piece of biographical work.

THE AMERICAN PLANT-BOOK, for the Convenient Preservation and Analysis of Pressed Flowers, Ferns, Leaves, and Grasses. By HARLAN H. BALLARD and PROCTOR THAYER. Slote & Co., 1879.

THIS book, which is neatly bound, provides for the fastening of about one hundred flowers upon its pages. Opposite the page which holds the plant there is printed a guide to the careful description of it, with blanks for the insertion of all particulars, and also for its classification. The frontispiece is an accurate engraving of poison ivy and poison sumach, the only plants in the northern United States which are seriously poisonous to the hand. Being brilliant and attractive, it is important that the collector should be warned beforehand, that he may avoid the danger. The book has also an introduction, with directions how to gather and press flowers. It is certainly a more desirable arrangement for its purpose than the home-made herbariums in common use.

LECTURE NOTES ON CHEMICAL PHYSIOLOGY AND PATHOLOGY. By VICTOR C. VAUGHAN, M. D., Ph. D., of the University of Michigan. Second edition, revised and enlarged. Ann Arbor Publishing Company. Pp. 315.

THE prompt sale of the first edition of these notes has led the author to enlarge it. Its character is expressed in its title, and it claims to be, not a complete treatise, but merely a practical guide to the working student. This book seems to be executed with care and judgment, and medical students especially who desire a thorough preparation in the physiological applications of modern chemistry will find it valuable.

THE COLOR-SENSE: ITS ORIGIN AND DEVELOPMENT. An Essay on Comparative Psychology. By GRANT ALLEN, B. A. Boston: Houghton, Osgood & Co. Pp. 282. Price, $3.50.

THIS is an interesting volume, on a topic that has come lately into prominence as one of the consequences of the theory of evolution. All pictorial art is of course based upon the color-sense in man, and it is an inquiry that can not fail to affect the theory of art whether this color-sense is an underived and always perfected faculty, or has grown through gradual stages to its present condition. That there has been a progress of taste capacity and art, founded upon the color-sense, is of course well known, but has the foundation itself been also developed? If it be admitted that it has, then there arises a new interest in the subject of color-sense as it exists among the inferior grades of animals. If color-sense and the color-perception are not to be taken as things unchangeable—if belonging to life they are a part of life, and are subject to the laws of life—then the question of the genesis of the color-faculty is legitimate, and it is proper to inquire what may have been the conditions of its origin. Professor Allen has entered upon this engaging study not merely with the enthusiasm inspired by its novelty and freshness, but in the genuine philosophic spirit, and well equipped with the scientific data for the investigation. The author's problem is, by what agencies, and under what reactions and conditions, the color-sense has originated in the grades of animal life. He finds it to be a faculty continuous throughout, but gradually unfolded and perfected, and he concludes that "the highest æsthetic products of humanity form only the last link in a chain whose first link began with the insect's selection of bright-hued blossoms."

Professor Allen combats the notion of Dr. Magnus, endorsed and popularized by Mr. Gladstone, that the color-perception of civilized man is a faculty of quite recent development, and that so lately as some three thousand years ago mankind was utterly incapable of distinguishing between violet, green, blue, and yellow. Rejecting this crude and ill-digested theory, the author remarks: "The few centuries which have rolled past during that interval form but a single pulse of the pendulum whose seconds make up the epochs of geological evolution. To me it appears rather that the color-sense of man is derived through his mammalian ancestry from a long line of anterior generations, and that its origin must be sought for in ages before a solitary quadrumanous animal had appeared upon the face of the earth." This book is an outgrowth of those studies which led the author to prepare his little volume on "Physiological Æsthetics"; but while that work was based upon human psychology, the last one relates rather to comparative psychology, or to the phenomena of mind throughout the whole animal world.

RELATION OF PHYSICAL EXERCISE TO CONSUMPTION, 16 pages; and FOUL-AIR-CONSUMPTION, 13 pages. By R. B. DAVY, M. D. Reprinted from the "Cincinnati Lancet and Observer."

IN the first of these pamphlets the author discusses the influence of muscular exercise on the more important organs of the body, and on the system in general, as affecting predispositions to pulmonary complaints, and as a means for the relief of such complaints when they have once obtained a foothold in the organism. Whether employed as a preventive or a remedy, he regards properly regulated exercise as an agent of the highest value; and among the several varieties described considers rowing as probably the best, and the health-lift as perhaps the worst, that can be adopted.

The second pamphlet is devoted to the subject of foul air as a cause of consumption, and explains how man by his habits of life and the conditions with which he surrounds himself becomes the source as well as the victim of the poison.

F. H.

THE NATIVE FLOWERS AND FERNS OF THE UNITED STATES. By THOMAS MEEHAN. Illustrated by Chromolithographs. Numbers from 12 to 24. Boston: L. Prang & Co. 50 cts. per No.

VOLUME II. of this elegant work is now complete, containing forty-eight neatly executed chromolithographs of our most interesting plants and flowers. The character of the work, text and illustrations alike, has been not only sustained but improved.

COAL, ITS HISTORY AND USES. By Professors GREEN, MIALL, THORPE, RÜCKER, and MARSHALL, of the Yorkshire College. Edited by Professor THORPE. New York: Macmillan & Co. Pp. 362. Price, $4.

THIS is a thoroughly popular book, but at the same time a fresh and instructive one. It originated in a course of lectures that were prepared for delivery in different places, by several professional gentlemen, each taking the topic with which he was most familiar. The volume has therefore something about it of authority and completeness, which give it merit. The subjects treated are "The Geology of Coal," "Coal Plants," "Animals of the Coal Measures," "The Chemistry of Coal," "Coal as a Source of Warmth," "Coal as a Source of Power," and "The Coal Question" (that is, the English question of the supply of coal), and the rates of its production and consumption. The volume is moderately illustrated, and is got up in good style.

ELEMENTS OF COMPARATIVE ANATOMY. By CARL GEGENBAUR, Professor of Anatomy and Director of the Anatomical Institute at Heidelberg. New York: Macmillan & Co. Pp. 645. Price, $7.

WE congratulate the publishers, Macmillan & Co., for their enterprise in bringing this sterling and standard Continental work to the service of English and American students. It has been demanded for a good while, and various publishers in London and New York have at divers times talked of coöperating with each other to reproduce it, but were all at last afraid of the venture. Mr. Macmillan has undertaken it alone, and we have no doubt that he will find "money in it." At all events, it is now *the* book upon the subject of comparative anatomy, for the relations of animal structures, that must be consulted by all students. Biological science has recently changed its course, by which the older treatises have become antiquated, and to meet the new requirements there must be new text-books. Lyell, when an old man, revolutionized his geology to bring it into harmony with advancing knowledge, and Gegenbaur has done the same thing with his great work on zoölogy. Dr. Lancaster, the editor, thus refers to this peculiarity of Gegenbauer's treatise: "We do not possess any modern work on comparative anatomy, properly so called; that is to say, a work in which the comparative method is put prominently forward as the guiding principle in the treatment of the results of anatomical investigation. The present work, therefore, appears to me to form a most important supplement to our existing treatises on the structure and classification of animals. It has, over and above this, a distinctive and weighty recommendation in that, throughout and without reserve, the doctrine of evolution appears as the living, moving investment of the dry bones of anatomical fact. Not only is the student thus taught to retain and accumulate his facts in relation to definite problems which are actually exercising the ingenuity of investigators, but he is encouraged and to a certain extent trained in the healthy use of his speculative faculties; in fact, the one great method by which new knowledge is attained, whether of little things or of big things—the method of observation (or experiment), directed by speculation—becomes the conscious and distinctive characteristic of his mental activity. Thus we may claim for the study of comparative anatomy, as set forth in the present work, the power of developing what is called 'common sense' into the more precisely fixed 'scientific habit' of mind."

LECTURES ON MATERIA MEDICA. By CARROLL DUNHAM, M. D. 2 vols. New York: Francis Hart & Co., 63 Murray Street. Pp. 828.

THIS is an elaborate text-book on the action of medical remedies, according to the theory of Hahnemann, and it is a treatise that will undoubtedly have weight with the professional school which it represents. Its author was Professor of Materia Medica in the New York Homœopathic Medical College, and author of "Homœopathy the Science of Therapeutics," and he is evidently recognized as a safe authority in this important branch of homœopathic medicine. The volumes are made up from his notes, observations, and memoranda, based upon close study and the experience of a wide practice. Dr. Dunham seems to have been an accomplished physician, loving his work and apt for it, and much liked by all who knew him. Of the merits of the medical system to which he adhered, our readers no doubt have their own opinions this way and that, with which

we have not the slightest inclination to meddle; but the volumes before us give evidence that their author was a learned, critical, and painstaking student in his chosen branch of professional inquiry.

FASTING GIRLS: THEIR PHYSIOLOGY AND PATHOLOGY. By WILLIAM A. HAMMOND, M. D. New York: G. P. Putnam's Sons. Pp. 74. Price, 75 cents.

DR. HAMMOND has done excellent service in contributing this little monograph to expose a class of the grossest frauds that grow rank in the soil of popular ignorance. He has not a very high opinion of our boasted enlightenment, as we gather from the following observations: "It seems that no proposition that can be made is so absurd or impossible but that many people, ordinarily regarded as intelligent, will be found to accept it and to aid in its propagation. And hence, when it is asserted that a young lady has lived for fourteen years without food of any kind, hundreds and thousands of persons throughout the length and breadth of a civilized land at once yield their belief to the monstrous declaration." Dr. Hammond gives accounts of several cases of alleged fasting girls and ingenious deceptions, the collusions and credulities of surrounding parties, and the manner of ultimate exposure. The final chapter, on the physiology and pathology of inanition, is very instructive.

PRINCIPLES OF POLITICAL ECONOMY. By WILLIAM ROSCHER, Professor of Political Economy at the University of Leipsic, Corresponding Member of the Institute of France, Privy Councilor to his Majesty the King of Saxony. From the thirteenth (1877) German edition, with additional chapters furnished by the author, for this first English and American edition, on Paper Money, International Trade, and the Protective System; and a Preliminary Essay on the Historical Method in Political Economy (from the French), by L. WOLOWSKI. The whole translated by JOHN J. LALOR, A. M. 2 vols. New York: Henry Holt & Co. Pp. 929. Price, $7.

THE students of economic literature owe hearty thanks to Mr. Lalor for rendering into English the learned work of Professor Roscher on political economy. It is a book of inexhaustible erudition, such as a plodding and untiring German Professor alone could produce. It abounds in curious information on a wide range of collateral topics, and runs freely into social philosophy as well as into strict economics. The notes are copious, varied, and invaluable.

INDEX MEDICUS. MONTHLY CLASSIFIED RECORD OF THE CURRENT MEDICAL LITERATURE OF THE WORLD. Edited by Dr. J. S. BILLINGS, Surgeon U. S. Army, and Dr. R. FLETCHER, M. R. C. S., Eng. Monthly. New York: Leypoldt. $3 per annum.

THE "Index Medicus" is a publication which can hardly fail to be heartily welcomed by the medical profession. It records the titles of *all new books* on medicine, surgery, and the collateral branches. These are classed under subject-headings, and are followed by the titles of valuable original articles in the medical journals, and the transactions of medical societies. The periodicals thus indexed comprise pretty nearly all the current medical journals and transactions of value. At the close of each yearly volume a double index of authors and subjects will be added, forming a complete bibliography of medicine during the preceding year. The "Index Medicus" contains about fifty pages of large quarto size, clearly printed on good paper. The valuable character of the work and its remarkably low price must commend it to the patronage of physicians.

THE TEACHER. HINTS ON SCHOOL MANAGEMENT. By J. R. BLAKISTON, M. A., one of Her Majesty's Inspectors of Schools. New York: Macmillan & Co. Pp. 91. Price, $1.

WE take it that this will prove a very helpful little work, on general schoolroom tactics, to that small circle of teachers who feel that they have any need of it, it being the business of teachers to know—and their standing, and salary, and influence in school and out of it depending upon their reputation for knowing, they can not generally afford to let it be suspected that they do not understand all about it—whatever it is. This book, by an old English school inspector, who says that his views "are the result of a personal experience of twenty-five years spent in educational work by one who feels

more every year how much he has yet to learn," proceeds upon the opposite principle. Indeed, the author goes so far as to say that when teachers are ignorant they should not have any false pride or pretension about it, but should honestly and openly admit their ignorance. His language is, "When children ask their teacher for information on subjects with which he has little or no acquaintance, he should not be ashamed of frankly owning his ignorance." This is sensible talk, and those who like it will find much more of the same sort in the volume, which will furnish many hints worth the attention of practical teachers.

MIXED ESSAYS. By MATTHEW ARNOLD. New York: Macmillan & Co. Pp. 347. Price, $2.

THE name of this author is so well and favorably known as to make any commendation of his work on our part superfluous. He deals with modern questions in the spirit of liberal, often of radical criticism, and his opening discussions on "Democracy" and on "Equality," from the point of view of an independent English thinker, will have interest for intelligent American readers. The London "Athenæum" remarks of the volume: "One feels that these essays are Mr. Arnold, and that the lesson they convey as a whole is more precious than any single principle expressed throughout them. It is the lesson of courtesy, gentleness, and toleration. The stern practical nature of life in the nineteenth century and the controversial fierceness which is at once the strength and the misfortune of Englishmen could have no better foil than this high-souled preacher, who has continually reminded us, by his own example, of the supreme value of noble conduct and high demeanor."

PUBLICATIONS RECEIVED.

Notes of a Naturalist on the Challenger. By H. N. Moseley. London and New York: Macmillan. 1879. Pp. 36. $7.50.

The Wyandotte Cave. By J. P. Stelle. Cincinnati: Moore, Wilstach & Baldwin. 1864. Pp. 85.

Etymological Dictionary of the English Language. By W. W. Skeat. Oxford: Clarendon Press. Part I., A—Dor. 1879. Pp. 176. 10*s.* 6*d.*

The Coal Trade. By F. E. Saward. New York: The Author. 1879. Pp. 73.

Practical Treatise on the Combustion of Coal. By W. M. Barr. With Plates. Indianapolis: Yohn Brothers. 1879. Pp. 315. $2.50.

Dictionary of Music and Musicians. London and New York: Macmillan. Part VI. 1879. Pp. 127.

The Art of Singing. By F. Sieber. New York: W. A. Pond & Co. Pp. 175. 1879.

L'Assommoir. By E. Zola. Philadelphia: Petersons. 1879. Pp. 380. 75 cents.

Progressive Japan. By General Le Gendre. San Francisco: A. L. Bancroft & Co. 1879. Pp. 370.

"Baptist Review." Quarterly. Cincinnati: J. R. Baumes. Vol. I. No. I. Pp. 172.

The Art of Figure-Drawing. By C. H. Weigall. New York: Putnam's Sons. 1879. Pp. 53. 50 cents.

Trial of D. M. Bennett. New York: "The Truth-Seeker." 1879. Pp. 189.

Haeckel's "Genesis of Man": a Review. By L. F. Ward. Philadelphia: E. Stern & Co. Pp. 64.

Supplementary Report on Sewer Air. By W. R. Nichols.

Sound Money. By D. A. Hawkins. Pp. 4.

Mothers' Marks. By Dr. R. Park. Pp. 13.

Ueber das von glühendem Platin ausgestrahlte Licht. Von Edward L. Nichols, Ph. D. Göttingen: Die Universitäts-Buchdruckerei von E. A. Huth. 1879. Pp. 58, with Plates.

On the Complete Series of Superficial Geological Formations in Northeastern Iowa. By W. J. McGee. From "Proceedings of the American Association for the Advancement of Science." Pp. 36.

Wall Rocks of the Bodie Auriferous Lodes. By M. Attwood. From "Proceedings of the California Geological Society." Pp. 3.

On an Improved Form of Gold-washer's Prospecting Bowl. From the "Alta California." By the same Author. Pp. 16.

Proposed Legislation on the Adulteration of Food and Medicine. By E. R. Squibb, M. D. New York: Putnam's Sons. 1879. Pp. 57. 25 cents.

All about the Plum Curculio. By J. B. Stelle. Mobile: "Register" print. 1878. Pp. 14.

Double Stars. By S. W. Burnham. From "American Journal of Science and Arts." Pp. 7.

Bigamy and Polygamy. Pp. 33.

The School Garden. By E. Schwab. New York: Holbrook & Co. 1879. Pp. 92. 50 cents.

Word and Work. By P. G. Robert. St. Louis: W. B. Chittenden. 1879. Pp. 29.

Evolution and Human Anatomy. By S. E. Chaillé. New York: Trow print. 1879. Pp. 21.

Heroes, Honors, and Horrors. Yellow Fever of 1878. By J. P. Dromgoole, M. D. Louisville, Ky.: Morton print. 1879. Pp. 176. 50 cents.

Catalogue of Plants in the Vicinity of Cincinnati. By J. F. James. Cincinnati: Barclay print. Pp. 27.

Mineral Locality in Fairfield County, Connecticut. By G. J. Brush and E. S. Dana. From "American Journal of Science and Arts." Pp. 10.

House of Representatives. Report of National Academy of Sciences. Pp. 25.

Method of Study in Social Science. By W. T. Harris. St. Louis: Jones print. Pp. 23.

POPULAR MISCELLANY.

The National Academy of Sciences.—Professor O. C. Marsh, who, after the death of Professor Joseph Henry, became acting President of the National Academy of Sciences, in his address at the annual meeting of that body, held in Washington, April 15th, presented a detailed statement of the action of the Academy with regard to the reorganization of the survey of the Territories. He also submitted a report of the progress which has been made in putting into execution Professor Newcomb's plan for determining the distance of the sun by measuring the velocity of light. Professor Marsh justly congratulates the Academy upon the unanimity with which the members adopted the scheme for reorganizing the surveys, and on its embodiment without change in a law of Congress. The Academy, in all its deliberations upon this important matter, was strictly unpartisan, and acted without respect of persons. Whether the scheme which now goes into execution will lead to better results than the old plan of many independent surveys, Professor Marsh leaves to the historian to decide. For the purpose of carrying out Professor Newcomb's plan of determining the sun's distance, the sum of five thousand dollars has been appropriated by Congress; and the work of constructing the necessary apparatus will be commenced as soon as the appropriation is available. It is hoped by those who proposed this plan that the experiments will lead to a more accurate determination of the distance of the sun than can be reached by any other method known to astronomers.

The Growth of a Continent.—The history of the growth of the European Continent, as recounted by Professor Geikie, gives an instructive illustration of the relations of geology to geography. The earliest European land, he says, appears to have existed in the north and northwest, comprising Scandinavia, Finland, and the northwest of the British area, and to have extended thence through boreal and arctic latitudes into North America. Of the height and mass of this primeval land some idea may be formed by considering the enormous bulk of the material derived from its disintegration. In the Silurian formations of the British Islands alone there is a mass of rock, worn from the land, which would form a mountain chain extending from Marseilles to the North Cape (1,800 miles), with a mean breadth of over thirty-three miles and an average height of 16,000 feet. The Silurian sea which spread across most of central Europe into Asia suffered great disturbance in some regions toward the close of the Silurian period. It was ridged up into land inclosing vast inland basins, the areas of some of which are still traceable across the British Islands to Scandinavia and the west of Russia. An interesting series of geographical changes can be traced, during which the lakes of the Old Red Sandstone were effaced, the sea that gradually overspread most of Europe was finally silted up, and the lagoons and marshes came to be densely crowded with the vegetation to which we owe our coal-seams. Later terrestrial movements led to the formation of a series of bitter lakes across the heart of Europe, like those now existing in the southeast of Russia. Successive depressions and elevations brought the open sea again and again across the continent, and gave rise to the accumulation of the rocks of which most of the present surface consists. In these movements the growth of the Alps and other dominant lines of elevation can be more or less distinctly traced. It was at the close of the Eocene period, however, that the great disturbances took place to which the European mountains chiefly owe their present dimensions. In the Alps we see how these movements led to the crumpling up and inversion of vast piles of solid rock, not older in geological position than the soft clay which underlies London. Considerable additional upheaval in Miocene times affected the Alpine ridges, while, in still later ages, the Italian Peninsula was broadened by the uprise of its sub-Apennine ranges. The proofs of successive periods of volcanic activity during this long series of geographical revolutions are many and varied. So, too, is the evidence for the appearance and disappearance of successive floras and faunas, each no doubt seeming at the time of its existence to possess the same aspect of antiquity and prospect of endurance which we natu-

rally associate with those of our own time. The law of progress has been dominant among plants and animals, and not less upon the surface of the planet which they inhabit. It is the province of the biologist to trace the one series of changes, of the geologist to investigate the other. The geographer gathers from both the data which enable him to connect the present aspects of nature with those out of which they have arisen.

Storms and Neuralgia.—At the April meeting of the National Academy of Sciences, Dr. S. Weir Mitchell read a paper on "The Relation of Neuralgic Pain to Storms and the Earth's Magnetism." The interesting observations here recorded were made by Dr. Mitchell in conjunction with Captain Catlin, of the United States Army, who lost a leg during the war, and who, since that time, has suffered from traumatic neuralgia, sometimes in the heel, but more frequently in the toes, of the lost foot. The hourly observations cover a period of five years. For the first quarters of these five years there were 2,471 hours of pain; for the second quarters, 2,102 hours; for the third quarters, 2,056 hours; and for the last quarters, 2,221 hours. The greatest number of hours of pain is in January, February, and March; and the least in the third quarters, July, August, and September. During these five years, while the sun was south of the equator, there were 4,692 hours of pain, against 4,158 hours while it was north of the equator; and the greatest amount of pain was in the quarters beginning with the winter solstice, and the least was in those beginning with the summer solstice. The average duration of the attacks for the first quarters was 22 hours, and for the third quarters only 17·9 hours. By taking the four years ending January 1, 1879, it is found that, of the 537 storms charted by the Signal Bureau, 298 belong to the two winter quarters, against 239 for the summer quarters. Hence we have the ratio of the number of storms of the winter quarters and summer quarters corresponding to the ratio of the amounts of neuralgia for these respective periods, and the ratio of average duration of each attack for the same time corresponds closely with the ratio of the respective total amounts of neuralgia for the same periods. The average distance of the storm-center at the beginning of the neuralgia attacks was 680 miles. Storms coming from the Pacific coast are felt farthest off, while storms along the Atlantic coast are associated with milder forms of neuralgia, and are not felt until the storm-center is nearer. Rain is not essential in the production of neuralgia. It was found that the severest neuralgic attacks of the year were those accompanying the first snows of November and December. Every storm, as it sweeps across the continent, consists of a vast rain area, at the center of which is a moving space of greatest barometric depression, known as the storm-center, along which the storm moves like a bead on a thread. The rain usually precedes this by 550 to 600 miles; but before and around the rain lies a belt which may be called the neuralgic margin of the storm, and which precedes the rain about 150 miles. This fact is very deceptive, because the sufferer may be on the far edge of the storm-basin of barometric depression, and see nothing of the rain, yet have pain due to the storm.

Physiological Action of Aconite.—From certain experimental inquiries into the physiological action of aconite and its alkaloid, *aconitia*, Dr. G. H. Mackenzie concludes that these drugs act primarily on the respiration by their influence on the respiratory center and peripheral sensory branches of the vagus nerve. They have no direct action on the heart, and only affect that organ secondarily through the medium of the lungs. Their action on the nervous system consists in firstly irritating and secondly paralyzing the peripheral sensory nerves and posterior roots of the spinal nerves. They have no direct action on the brain or the vaso-motor nerves. They increase the irritability of the peripheral motor nerves, and of the motor columns of the cord. They do not induce muscular paralysis, but, on the contrary, increase the irritability of voluntary muscle. They induce convulsions mainly through their augmenting the irritability of the anterior column of the cord, the motor nerves, and muscles. They firstly increase and secondly diminish temperature. Death ensues from asphyxia and respiratory collapse.

Curiosities of Nervousness.—An interesting book might be made out of the curiosities of nervousness from a contemporary standpoint. The elder Disraeli has somewhere a chapter on the subject; but, if our memory serves us correctly, his instances trench rather upon the hysterical conditions, the monomanias, the wild fanciful delusions of the disordered imagination, than upon the prosaic features of the distemper. He instances men who could not bear the sight of old women, and fainted dead away if a grandmother showed herself; others who, if they heard a rat in the wall, took it for a ghost and got up and prayed fervently; and such things. The present age furnishes more rational imaginings, born of the daily papers, emphasized by indigestion, and riveted by the surprising eloquence of the diurnal quidnuncs. For instance, there are plenty of people living at this moment who would warmly refuse to get into bed before looking under it to make sure that no man lay there. There are others who pass the night in constant fear of fire; who, before they withdraw to their bedchambers, carefully rake out every fireplace in the house, turn off the gas, inspect every room, knock on the servants' doors and inquire through the key-holes if their candles are out; and after all this bother go to bed and lie awake until the dawn with their bedroom doors ajar, sniffing at imaginary fumes of burning, and ready to spring out and go raving mad should anything like a cry be raised—for these people never make any serious provision against fire should fire come. There are others, again, who will lie night after night in expectation of burglars. A distant footfall will court them to the window, where, cautiously pulling aside the blind by the breadth of a nose (giving scope to one eye), they will peer into the gloom and mistake some shadow for the figure of a man (wrapped in an overcoat and with a horse-pistol in every pocket), intent upon the particular window whence he is being watched. Others will be kept awake by the song of the wind about the casement, or in the empty rooms around, confounding these natural sounds with the murmur of human voices in the pantry, or on the landing just outside.

These are some of the hundred night fears beyond an ordinary imagination to express. But there are daylight fears as numerous, if not always so agonizing. What words can convey the horror felt by a certain kind of nervous people who, making a journey on a railway, are suddenly brought to a stand in a tunnel? Nothing can comfort them. Their heads shoot through the windows, their cries lacerate the gloom, and the reassuring shouts of the guard only aggravate their fright and provoke fresh yells for immediate release. Or take the mental condition of another kind of nervous persons at sea. Every roll of the vessel means imminent death. The carrying away of a water-cask, the momentary stoppage of the engines, the cry of a man on the lookout, the escape of a sail from the gaskets that confine it to the yard, and its consequent bellowing upon the gale, the abrupt shipping of a sea, nay, the tumbling of a steward down a ladder, or the fall and smash of a few plates from the leaning saloon table, will strike an indescribable horror, and lead to no end of convulsive clingings and mumblings of prayer. Indeed, it would be possible to fill every page in this journal with a catalogue of the imaginative afflictions under which nervous people labor. Old Doctor Johnson, going back to touch an omitted post, typifies a host of numerous disorders which need not be mistaken for superstitions, and which assume a vast number of shapes among us in these days. Take a pavement full of people with a ladder across it from the house-top to the curbstone. How many of the passengers will wade into the mud of the road to save themselves from passing under that ladder? The proportion of the nervous people in the world will be happily indicated by such an example. Of every hundred persons, we question if ten would, without hesitation, pass under that ladder. When a man refuses to make his will, because he fears that by doing so he will be hastening his death, are we not to attribute his cowardice to the nerves? It is a mere convenient apology to call such misgivings superstitions. No one would hope to cure a priest's faith in a winking Madonna by a course of quinine; and superstitions of the real sort are assuredly not to be corrected by medical treatment. But our latter-day nerves *are* to be dealt with, and

a good many uncomfortable horrors taken out of our minds, by the judicious doctor. —"Mayfair."

A Botanical Usurper.—One of the most curious instances on record of the invasion of a country by a plant of foreign origin, and the extermination by it of indigenous species, is seen in the history of the mango-tree in the island of Jamaica, as recounted by Sir Joseph Hooker. It reminds us of the accounts of captured tribes which after being carried into their conquerors' country have so increased and multiplied as eventually to dispossess and supplant their captors. In 1782 Admiral Rodney captured a French ship bound for San Domingo from Bourbon, with living plants of the cinnamon, jack-fruit, and mango, sent to the Botanic Garden of the former island by that of the latter. The prizes were presented by the Admiral to the Jamaica Botanic Garden. There the cinnamon was carefully fostered, but proved to be difficult of culture in the island; while the mango, which was neglected, became in eleven years as common as the orange, spreading over lowlands and mountains from the sea-level to 5,000 feet above it. On the abolition of slavery immense tracts of land, especially coffee plantations, relapsed to a state of nature, and, the mango being a favorite fruit with the blacks, its stones were flung about everywhere, giving rise to groves along the roadsides and around the settlements; and the fruit of these again, rolling down hill, gave rise to forests in the valleys. The effect of this spread of the mango, Sir Joseph Hooker adds, has been to cover hundreds of thousands of acres, and to ameliorate the climate of what were dry and barren districts by producing moisture and shade, and by retaining the rainfalls that had previously evaporated; all this, besides affording food for several months of the year to both negroes and horses.

Explorations in Central Africa.—Two French travelers, M. Savargnan de Brazza and Dr. Ballay, have returned to Paris after a three years' exploration of the Ogowé (or Ogobai) River. In August, 1875, the travelers left Lambarene, the extreme limit of the European factories, and, escorted by twelve Laptots, or native African soldiers of the French colony of Senegal, explored the river to its sources. One result of the expedition is to prove that the Ogowé does not rise in an interior lake. The river may be divided into three nearly equal parts—the upper, the middle, and the lower. The middle follows an almost straight east and west course just south of the equator; the two others incline about a degree and a half toward the south. The first halt was made at Lopé, a large village on the upper Ogowé. M. de Brazza penetrated into the country of those noble cannibals, the Fans, with whom he entered into friendly relations, and succeeded in reaching Dumé, a position considerably advanced on the upper river. He suffered seriously in this journey, and on his return had to let his companions advance to Dumé without him; he was only able to rejoin them in April, 1877. Through great hardships and dangers they made their way to the Pubara Fall, above which the Ogowé becomes an inconsiderable stream.

After a few days' rest here, the explorers left the basin of the Ogowé in March, 1878, to penetrate still farther into the interior. They traversed successively the territories of the Ondumbo, the Umbeté, and the Bateké, suffering greatly on the way from both hunger and thirst, for the country was devastated by famine. A stream running east, the N'Gambo, led the explorers to an important river, the Alima, 500 feet wide and sixteen feet deep, apparently an affluent of the Congo. In attempting to descend the Alima they had to run the gantlet between banks lined with hostile savages. They quitted the river and marched northward, crossing many watercourses flowing eastward. They suffered so much from hunger that the expedition had to be divided, Dr. Ballay and one of the attendants being sent back to the Ogowé. M. de Brazza went some distance farther northward, when hunger and suffering compelled him also to retreat, and he rejoined his comrade in September. On November 30th the whole party reached the French settlement at the Gaboon.

From Corisco Bay, on the west coast of Africa, and a little north of the mouth of the Gaboon, comes intelligence of certain important explorations made by Hugo de Koppenfels, who reports that he ascended the Muni, the Noya, the Balinji, and the

Tambuni to the first falls. In the Crystal Mountains he fell in with tribes absolutely unknown up to the present, or who at least had not been seen by whites with rare exceptions—the Etemo, the Manga, the Otonto, and the Toko. These people are described as very inoffensive; they regarded their white visitor as a curious animal, and had a certain fear of him. When he asked them to accompany him into the interior they agreed readily. They are frightfully poor, being obliged to give up planting on account of the ravages of elephants and gorillas, which are very numerous and daring. Not a single night passed, the traveler states, that he did not hear those animals ravaging around the villages, which are mostly very large. As soon as the animals are known to be near, the whole village is on foot endeavoring to frighten them away by shouting. In these nocturnal expeditions, in which the explorer took part, he noticed that the head man of the village addressed a speech to the elephants, and that in this speech his own name was pronounced. He was told that the elephants were threatened to be handed over to him, and that, if they did not fly at once, they would be visited on the morrow, and the white man would kill them. If the elephant seizes a plant with its trunk, the people immediately raise a dreadful, plaintive howling, and the principal orator addresses, in a lamentable voice, supplications to the enormous brute.

The Annual "Outing."—That the change of scene and air secured by an annual "outing" is beneficial to health can not be doubted. The relief afforded counts for much, the opening up of new sources of energy counts for more, in the sum of advantages gained. Meanwhile, not only will the profit be small, but the result questionable, unless the relief and the sense of freshness are shared by mind and body alike. In a word, perfect absence of *worry* is essential to the full enjoyment and restorative action of the holiday. This is just what the majority of persons, particularly the heads of families, forget, for themselves and those around them. A jaded mind needs rest quite as much as a weary body, and neither the one nor the other can obtain the sort of rest which is essential to a complete renewal of strength without the awakening of new interests. The simple cessation of work may in some few instances give relief, but much more than this is necessary for the recovery of health and renewal of energy when mind and body are exhausted by long-continued or monotonous toil, or domestic duty. It follows that, in the choice of a locality and in the manner of conducting the trip, the inclination should be consulted not less than general convenience. It is too much the practice to make a toil of a pleasure, and create occasions of annoyance in the course of the annual holiday. Everything should be planned to leave the mind free as regards the obligations of home duty, and enable it to share the advantages of the change bestowed on the body. There is plenty of thought for the physical part of man's nature; it may not be unreasonable to put in a plea for the consideration of his needs as a being endowed with a mental part, which is apt to be overmuch burdened with responsibility and harassed by many cares. The annual outing will be incomparably more enjoyable, and productive of lasting benefit, if these needs of the mind are considered, instead of being systematically overlooked. People go away anxious, and return to mourn over the smallness of the benefit they have received. They took their worries with them, and might almost as well have staid at home.—*Lancet.*

What is a Poison?—Under the fanciful title of "The Keys of Death," we find in the "Monthly Journal of Science" a very interesting article on the subject of poisons. The author asks, in the first place, what is a poison, but science, he holds, is not yet qualified to give an answer. Certain physiologists have concluded that whatever is poisonous in large doses must also be poisonous in the minutest. But it is easy to give instances where, if the reagents employed are less in proportion, or weaker than the required standard, we obtain, not a smaller quantity of the product sought for, but a substance totally different. Oxygen is a case in point: diluted, it sustains life; pure, it destroys it. So with sulphuric acid. Mixed largely with water, it is a refreshing, tonic beverage; in the concentrated state it destroys all parts of the system which it touch-

es. Again, a definition of poisons has been based on the fact that while certain articles of food undergo decomposition in the stomach, poisons do not. Then water is a poison, for it does not suffer decomposition in the system.

But, turning aside from these definitions, we find included under the general name of "poisons" two very different classes of bodies, viz., "germs" which, when absorbed by an animal, bring on such diseases as rabies, small-pox, cholera, etc.—in short, the zymotic diseases; and, in the second place, the true poisons, such as arsenic, strychnine, aconitine, etc. These latter substances are well-defined chemical individuals. When introduced into the system they set up morbid action almost immediately, and if the dose be sufficient the symptoms go on increasing in violence till death ensues. A characteristic feature is that their noxious power may be decreased or even extinguished by dilution.

The other class, however, the ferments, are not definite chemical principles, capable of being isolated, of entering into combination with other bodies, and of being separated again; they are, so far as we know, living organisms of low type.

The immunity of certain animals from the action of poisons which are fatal to others is remarkable. This difference of susceptibility often exists between individuals of the same species, being developed in some cases by natural selection, in others by habituation. The author of the paper in the "Journal of Science" gives the following list of caterpillars which feed on poisonous plants: *Gonopteryx rhamni*, on *Rhamnus catharticus*; *Thais polyxena*, on species of *Aristolochia*; *Danais archippus* and *chrysippus*, upon various *Asclepiads*; *Deilephila galii*, *Nicea*, and *Euphorbiæ*, on species of *Euphorbia*; *Chærocampa nerii*, on the oleander; *Sphinx polia cappa*, on staves-acre; *Heliothisa armigera*, on tobacco; and *Chrysoptera moneta*, on monk's-hood.

A New Electric Pen.—In the "Monde de la Science" is a description of an improved electric pen, much cheaper than Edison's, and not so fatiguing to the operator; the inventor would appear to be an Englishman, Wentworth L. Scott. The pen consists of an open glass tube drawn out to a point at one end, where there is a minute orifice. Within the tube is a copper wire, to which a fine platinum point is soldered toward the lower end of the pen. This copper wire is held in the middle of the tube by means of a cork stopper at the larger end (the upper end of the pen). The point of platinum should just reach the tip of the pen. To work the instrument the copper wire is connected with one of the poles of a Ruhmkorff coil. The other pole is connected with a zinc plate, on which the paper is to be laid. The circuit is now closed, and so soon as the current flows it causes the interrupter of the Ruhmkorff coil to vibrate. The pen is then made to move over the paper, as in writing, care being taken only to touch the glass tube, for fear of electric shocks, and electric sparks are seen to pass with great rapidity between the point of the pen and the paper. On holding up the paper between the eye and the light, the track of the pen is seen to consist of minute perforations, like those produced by Edison's electric pen. The instrument is as light as a common pen. The cost of the whole apparatus is trifling, about eighteen francs.

Alum as an Adulterant of Baking-Powders.—Dr. Henry A. Mott, Jr., employed as chemist for the Indian Department, having made analyses of different baking-powders, publishes in the "Scientific American" as the result of his investigations the statement that at least fifty per cent. of the many baking-powders examined by him were grossly adulterated. Dr. Mott found that the injurious powders are composed of alum and bicarbonate of soda, oftentimes containing also terra alba, insoluble phosphate of lime, etc. The best powders are composed of bitartrate of potash (cream of tartar), tartaric acid, carbonate of ammonia, and bicarbonate of soda, held together by a little starch to prevent decomposition. The injurious effects of alum on the digestive organs have been pointed out by eminent chemists and physicians: it produces dyspepsia, constipation, vomiting, griping; it is a powerful astringent, acting chemically on the tissues. Says Dumas, the French chemist: "It is to be feared that this salt (alum) exerts a deadly action by its daily introduction into the

stomach, especially in persons of weak constitution." Liebig condemns the use of alum in bread-making on this ground among others, that it combines with the soluble phosphates, forming insoluble salts, and thus the phosphorus of the grain is lost to the system. Dr. Mott's paper exhibits as follows the results of the analysis of four brands of baking-powder:

DOOLEY'S STANDARD BAKING-POWDER.

Burnt alum	26·45 per cent.
Bicarbonate of soda	24·17 " "
Sesquicarbonate of ammonia	2·31 " "
Cream of tartar	None
Starch	47·07 " "
	100·00

PATAPSCO BAKING-POWDER.

Burnt alum	20·03 per cent.
Bicarbonate of soda	22·80 " "
Cream of tartar	None
Starch	57·17 " "
	100·00

CHARM BAKING-POWDER.

Burnt alum	30·06 per cent.
Bicarbonate of soda	31·82 " "
Cream of tartar	None
Starch	38·12 " "
	100·00

BAKING-POWDER MANUFACTURED BY C. E. ANDREWS & CO., MILWAUKEE, WIS.

Burnt alum	22·53 per cent.
Bicarbonate of soda	21·79 " "
Cream of tartar	None
Starch	55·68 " "
	100·00

Adulteration of Food and Drugs.—Some astounding facts with regard to the adulteration of articles of food and medicine are brought together by the "Medical and Surgical Reporter," being taken from various medical and pharmaceutical periodicals. Thus we are told that in New England several mills are engaged in grinding white stone into powder for purposes of adulteration, three grades of powder being ground at some of the mills, viz., a soda grade, a sugar grade, and a flour grade. A Boston chemist has found seventy-five per cent. of terra alba in a sample of cream-tartar; and most of our confectionery contains thirty-three per cent. or more of this substance. These and many other adulterations of materials used in the preparation of food have been pointed out in "The Sanitarian." The adulteration of drugs is practiced to such an extent that "in some localities a conscientious pharmacist is hardly able to earn a livelihood, owing to the mean and dishonest competition which surrounds him." "Salicine," writes a physician in a Louisville medical journal, "is heavily adulterated by mixing it with cinchonidia sulphate." Again, the editor of "The Pharmacist" sought in vain among the druggists of Chicago for black sulphuret of antimony. He obtained what purported to be that substance at seven wholesale drug-houses; but not a trace of antimony was to be found in any of the samples! Analysis showed it to be in most cases simply marble-dust blackened with soot.

Pinto's Trip across Southern Africa.—A telegram received at Lisbon, on March 11th, announced the arrival of Major Serpa Pinto on the eastern coast of Africa, after having traversed the continent from Benguela on the west coast. We take from "Das Ausland" the following account of Major Pinto's memorable journey: On November 12, 1877, he set out from Benguela, in Lower Guinea (about latitude 13° south), and on March 8, 1878, entered the negro kingdom of Bihé, where he had his first fight with the natives. He devoted himself particularly to the exploration of the upper and middle Zambesi, that grand stream which, lying some ten degrees of latitude south of the Congo, like that river traverses almost the entire breadth of the African Continent. If it is the purpose of Portugal to found in equatorial Africa another Brazil, the most accurate knowledge of the course of the Zambesi must be of the utmost importance to her. Portugal controls the coast on both sides, the western and the eastern, in equatorial South Africa, and, if she succeeds in establishing communication between these two coasts by means of the Zambesi, the new colonial empire would be a fact. This project is favored by the wealth of gold found in the lower Zambesi regions, and it is surely no mere accident that latterly the Government has been making large concessions to English and Portuguese companies. Incidentally Major Pinto appears to have revealed the mystery of the Cubango, a stream whose sources are not

very distant from those of the Zambesi, but which soon takes a north and south direction. Only the upper course of this stream was hitherto known to Europeans. It was supposed that farther down it turned to the west and flowed into the Atlantic as the Owambo or Cunene. Pinto has now probably made the discovery that the Cubango is a tributary of the Zambesi. However this may be, our knowledge of the interior of Africa has been considerably enlarged by Pinto's journey.

On reaching the Transvaal Territory the explorer sent the following dispatch to the King of Portugal: "I am now six days' journey from the Indian Ocean, and on the point of completing my march across Africa from the west coast. I have struggled against hunger and thirst, wild beasts, savages, floods, and drought, and have happily surmounted all these obstacles. My records are safe, and consist of twenty geographical charts, three volumes of important coördinates, meteorological notes, three volumes of sketches, and a voluminous journal. I have lost several men. Complete study of the upper Zambesi, sixty-two cataracts and rapids. Plan of the cataracts. The natives fierce; unceasing wars. The secret of the Cubango. SERPA PINTO."

Strength of Hard and Soft Steel.—It has hitherto been supposed that a soft bar of steel can longer resist the disintegrating action of strains and shocks than a hard one, but experiments made by W. Metcalf, of Pittsburg, appear to prove the contrary to be the fact. His attention was first called to this matter by the constant breaking of steam-hammer piston-rods. Made of ordinary steel, they lasted but six months, an iron rod lasting but half as long. Then lower and lower steels were tried, and broke in about five months. In an emergency, a rod of comparatively high steel was employed, and this, which it was supposed could not serve for more than a week or two, held out for more than two years. This result led Mr. Metcalf to investigate the whole subject systematically, and a lot of small steel connecting-rods were tested in a special machine. The test required was, that a machine should run 4½ hours at a rate of 1,200 revolutions per minute, unloaded, before the connecting-rod broke. These rods were unforged in the middle, and consisted of a piece of round bar with a head welded on each end. "The mode of rupture was," says Mr. Metcalf, "as a rule, the same in all cases; the rod heated at the middle, where the vibrations met, as they were imparted by rotary motion at one end, and by reciprocating motion at the other, and by alternating strains of compression and extension. In some cases the rod became slightly red-hot at the middle before rupture. After heating, the next thing observed was the raising or loosening of the surface scale of the middle. Soon after this, rupture began, first at the surface and gradually extending to the center. The breaking was gradual in every case, no piece breaking suddenly, even of the highest steel. The first trial was with ·53 carbon steel: mean time of six trials, 2 hours 9½ minutes. Second trial, ·65 carbon steel: mean time of six trials, 2 hours 57½ minutes. Third trial, ·85 carbon steel: mean time of three trials, 9 hours 45 minutes, and the trials were stopped." A set of twelve connecting-rods, made from special ingots, was then prepared. These were tested with the following results:

The ·30 C ran 1 hour 21 minutes, heated and bent before breaking.

The ·49 ran 1 hour 28 minutes.

The ·53 ran 4 hours 57 minutes, broke without heating.

The ·65 ran 3 hours 50 minutes, broke at weld where imperfect.

The ·80 ran 5 hours 40 minutes.

The ·84 ran 18 hours.

·87 C broke in weld near the end.

·96 C ran 4 hours 55 minutes, and the machine broke down.

The whole twelve were not tested, because the machine was needed for other works, and, when Mr. Metcalf returned to complete the experiment, it was discovered that the foreman of the shop had picked up the unbroken specimens, put them into machines, and sent them off. Enough was done, however, to show that the maximum of strength to resist vibration was not found among the ductile steels. Mr. Metcalf gives some other data concerning the performance of steel suspension-rods in a bridge that corroborate his views, which are practically novel.

NOTES.

In a cave near Decatur, Ohio, were recently found, imbedded in ashes, fragments of human bones, pieces of pottery, also bones of wild animals, shells, etc. According to a correspondent of the "Marietta Register," the human jawbones found in this cave are very large, and have the teeth well preserved. They have one tooth back of the "wisdom-tooth." All the long bones were broken or split—a probable indication of cannibal practices.

A curious fact in the history of the yellow-fever epidemic last year, in New Orleans was, that in the Fourth District, the death-rate of males was seventy per cent. greater than that of females, though the sanitary census of 1877 showed that the female population of the district exceeded the male by 1,261. The comparative immunity of the negro race appears from the fact that while the white population of the district (29,482 souls) lost 569 persons by death, the black population (6,883 souls) lost only 29. If the negroes had died in the same ratio as the whites, they would have lost about 130.

As an illustration of the sudden extreme alternations of temperature in northern Dakota and Montana, Dr. P. F. Harvey, U. S. Army, states that in August, 1876, while on duty with an expedition against hostile Indians, he saw the thermometer record 116° Fahr. in the shade at the mouth of the Rosebud River; thirty-six hours afterward, the temperature had fallen to very nearly the freezing-point; and, on the morning of the second day following, he scraped hoar-frost from a log in front of his tent.

The "Examiner" notes an extraordinary decrease in the number of students of theology at the German universities. The decrease is so great that in several states there has been an insufficiency of candidates for the pulpit. Until now Schleswig-Holstein was an extensive nursery of theologians, but there also a falling off by nearly 40 per cent. has recently occurred. At Kiel there are at present 24, at other German universities 28 students of theology from Schleswig-Holstein—altogether 52. Six years ago there were still 90 of them, while fifty years ago there were no less than 168 students of theology at Kiel alone, almost all of them Schleswig-Holsteiners.

Underground telegraph cables are now completed between Berlin and Cologne, Cologne and Elberfeld, Frankfort and Strasburg, and Hamburg and Cuxhaven; the total length of these lines is 1,554 miles, and the cost about $3,000,000.

The suggestion is made in "Dingler's Polytechnisches Journal" that air for ventilation be drawn into buildings through tubes sunk about three metres in the ground (say ten feet). By this means it would in winter be warmed 15° or 16° Fahr., and in summer cooled 20° to 23° Fahr.

Peter Le Neve Foster, for twenty-five years Secretary of the London Society of Arts, died recently, at the age of seventy years. A lawyer by profession, Mr. Foster took a lively interest in various departments of science. He was one of the first to practice, as a scientific amateur, the art of photography, and was a frequent contributor of articles on that subject to periodicals and cyclopædias. He was President of the Queckett Microscopical Club for one year, and from 1863 to 1866 served on the Council of the British Association.

The London Geological Society has awarded the Bigsby Medal to Professor E. D. Cope, of Philadelphia, in recognition of his services to the science of paleontology.

In Brazil the coffee plantations, like the vineyards in France, are threatened with destruction by the ravages of a minute parasite. The roots of the plants are found covered with knots and swellings like those seen on the roots of the grapevine infested by the phylloxera. In these swellings are found minute nematode worms one fourth of a millimetre in length when fully developed. A single root often contains as many as fifty million of these parasites.

The larva of the tapeworm known as *Tænia solium* comes from "measly" pork, and the mature worm has a head bearing a crown of hooks. *Tænia mediocanellata* is derived from beef and mutton; it has a larger head, which is unarmed. It has commonly been supposed that the former species is more frequently found in human subjects than the latter, but Professor Leidy is of the contrary opinion. Thorough cooking of meats is a sure preventive of the development of these unwelcome entozoa.

An apparatus, the invention of an American, for carrying a line to a vessel in distress was lately tested in England. It consists of a projectile weighing 12½ pounds, the necessary line included. This projectile is placed in a gun, the wrong or heavy end first, and on leaving the muzzle, at once turns over, the front end becoming the rear. In shape it is an elongated shell 12½ inches long, 3¼ inches in diameter, carrying a line tightly coiled within, which it pays out as it flies through the air. At 22° elevation, the distances reached by the projectile were 389, 448, and 507 yards, the deviation of the shot and line from the target being 4½, nine, and eight yards respectively.

JULIUS ROBERT MAYER.